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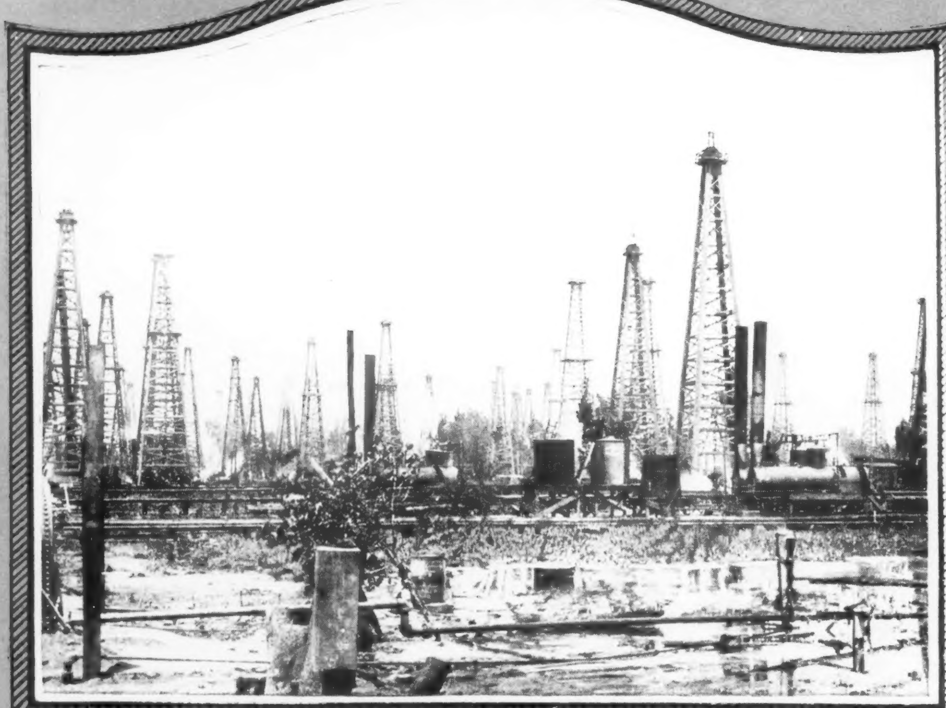

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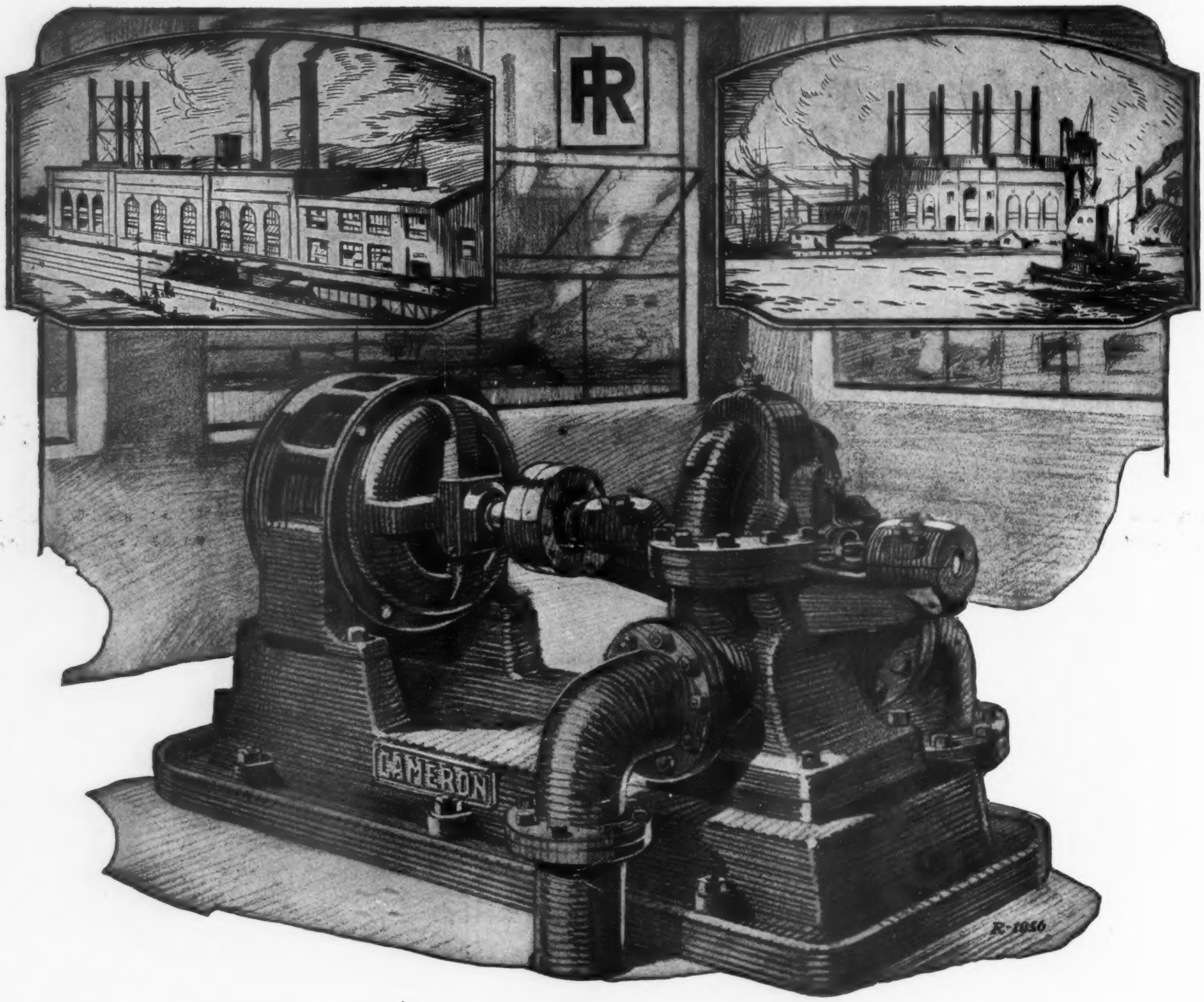

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JULY, 1926

Vermont's Varied Marbles

Origin of These Age-Old Deposits and the Splendid Industry That Has Developed in Exploiting Them

By ROBERT G. SKERRETT

VERMONT marble, as the result of man's labors, is the product of an industry that has reached splendid proportions only within the last half hundred years. And this industry, in its turn, is the consequence of Time's erosive action which brought to the surface of the Vermont Valley occasional outcroppings of a snowy rock that attracted the early settlers of the region when they were casting about for an enduring material from which to fashion hearthstones.

Those pioneers found that slabs broken off from the exposed ledge, aside from their attractive whiteness, possessed fire- or heat-resisting properties; and thus with the passing of years marble became in that region the symbol of the home gathering place that spread warmth and cheer when winter winds blew without and the ground lay deep beneath a cloak of snow. Slowly but steadily other uses were found for the marble intermittently quarried here and there in the neighborhood of the Green Mountains; and each new application emphasized the enduring character of the stone. It was inevitable that the beauties of the material should eventually attract and arrest the artistic eye of the sculptor and the architect; and this, in its turn, opened up ever widening fields of utilization.

Admittedly beautiful as Vermont marble is in all its fifty different varieties, still who would look for a quickening subject in a substance that is naturally cold no matter how warm its hue? And yet there is in the story of Vermont marble—tracing the record from the dawn of time down to the present day—enough to stir the imagination of all but the most phlegmatic among us.

Vermont marble, as a substance of Nature's making, is the outcome of terrestrial changes, of titantic forces that played their several parts perhaps millions of years ago. By one of those strange paradoxes of indeterminable time—time measured by the finite mind of man, every imposing marble structure is in effect a monument to a period in the world's history when more or less diminutive marine creatures gave up the ghost and surrendered their limy bodily structures that gradually formed the initial mass from which Vermont's marble beds were born.

THROUGH the ages, marble has been the prized stone of the architect and the sculptor. Out of this enduring material were built many of those ancient structures that still survive to give pleasure to the eye and to occasion admiring wonderment.

Similarly, the sculptor of long ago chiseled out of marble those examples of grace and physical perfection that are sources of inspiration for the master craftsmen of the present day. But for the nearly everlasting nature of marble, modern civilization might be unaware of many of the artistic achievements of the peoples that have passed.

Much of the most beautiful of the marbles now utilized in America comes from the quarries of Vermont. These deposits are worked today to an extent undreamed of by those pioneers that first began to break off slabs from the snowy outcroppings more than a hundred years ago. The marble industry in Vermont has overcome many difficulties in developing its unique geological resource so that it might supply marbles of numerous kinds suited to the varied needs of the architect and the artist.

Most of the marble now quarried in Vermont is obtained from deposits lying in the valley or valleys immediately west of the towering Green Mountains. These seemingly "everlasting hills" are not evidence of geological permanence, but just one more proof of the many changes that have taken place in the earth's crust in the formative period of the globe as we know it today. Long before the Green Mountains thrust their shoulders out of the primordial sea, the marble now quarried was either in the making or already made and possibly aeons old. Again, the very material of which the uppermost mass of those mountains is formed had much to do in producing the various marbles for which Vermont is rightly famous. We shall all look upon marble more understandingly if we recall what the scientist has ascertained about its genesis.

The calcite marble quarried in the Vermont Valley is composed in part of about 56 per cent. of carbonate of lime—in other words, lime is the predominating ingredient. A chemical precipitate of carbonate of lime, when examined under a microscope, is found to consist of an aggregation of irregular and extremely minute granules of uncrystalline matter. This carbonate of lime is chemically identical with what is technically described as marble. However, there is a physical difference between the two. For instance, when a thin section of marble is placed under a microscope, the lenses reveal that the marble is not composed of granules but is made up of translucent or transparent crystalline plates that are bound together in a distinctive manner—thus marble differs from limestone, which is really its parent. But why should marble differ from limestone? To answer this question we must go back to that very remote era in the history of our continent when the region now dominated by the Green Mountains lay deep in the

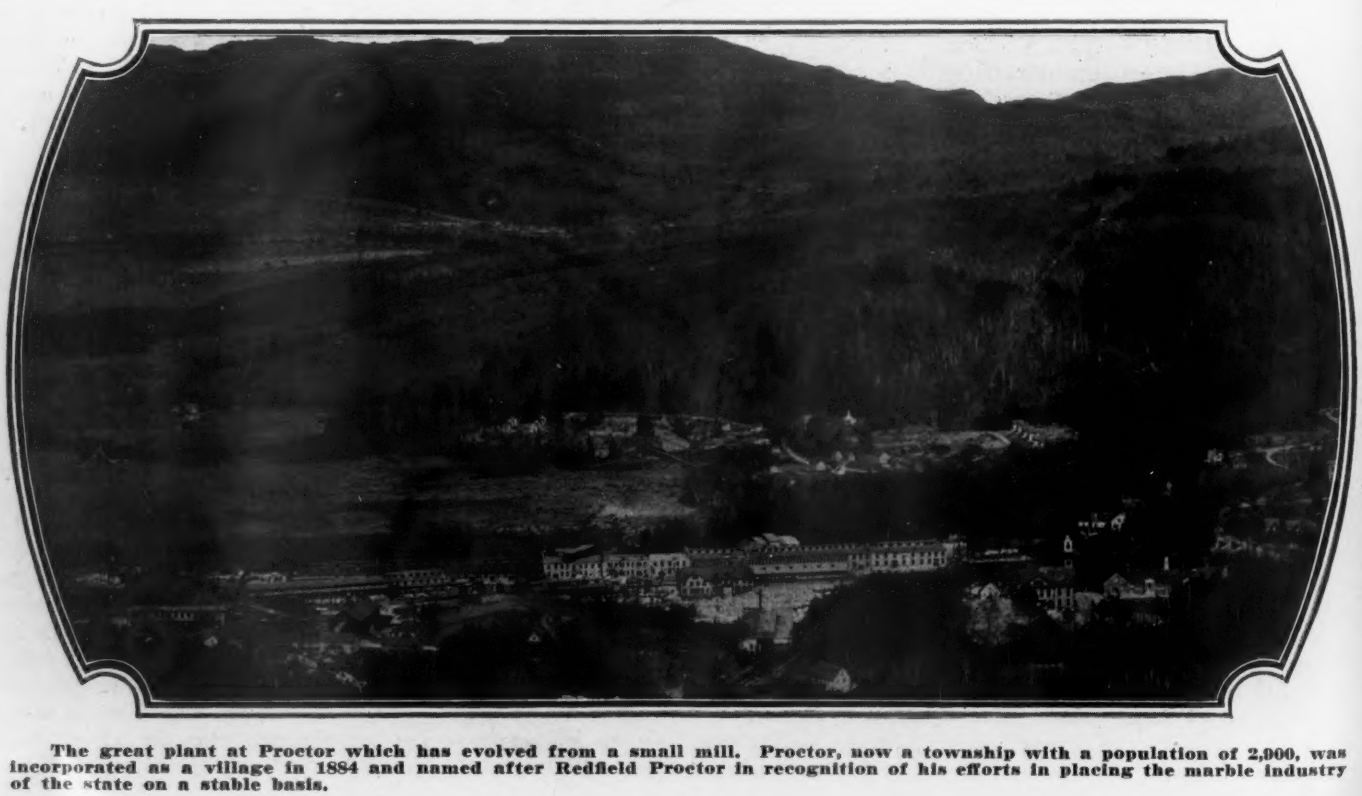
Aspects of picturesque Proctor.

bosom of a sea that was then probably part of what we now call the Atlantic Ocean.

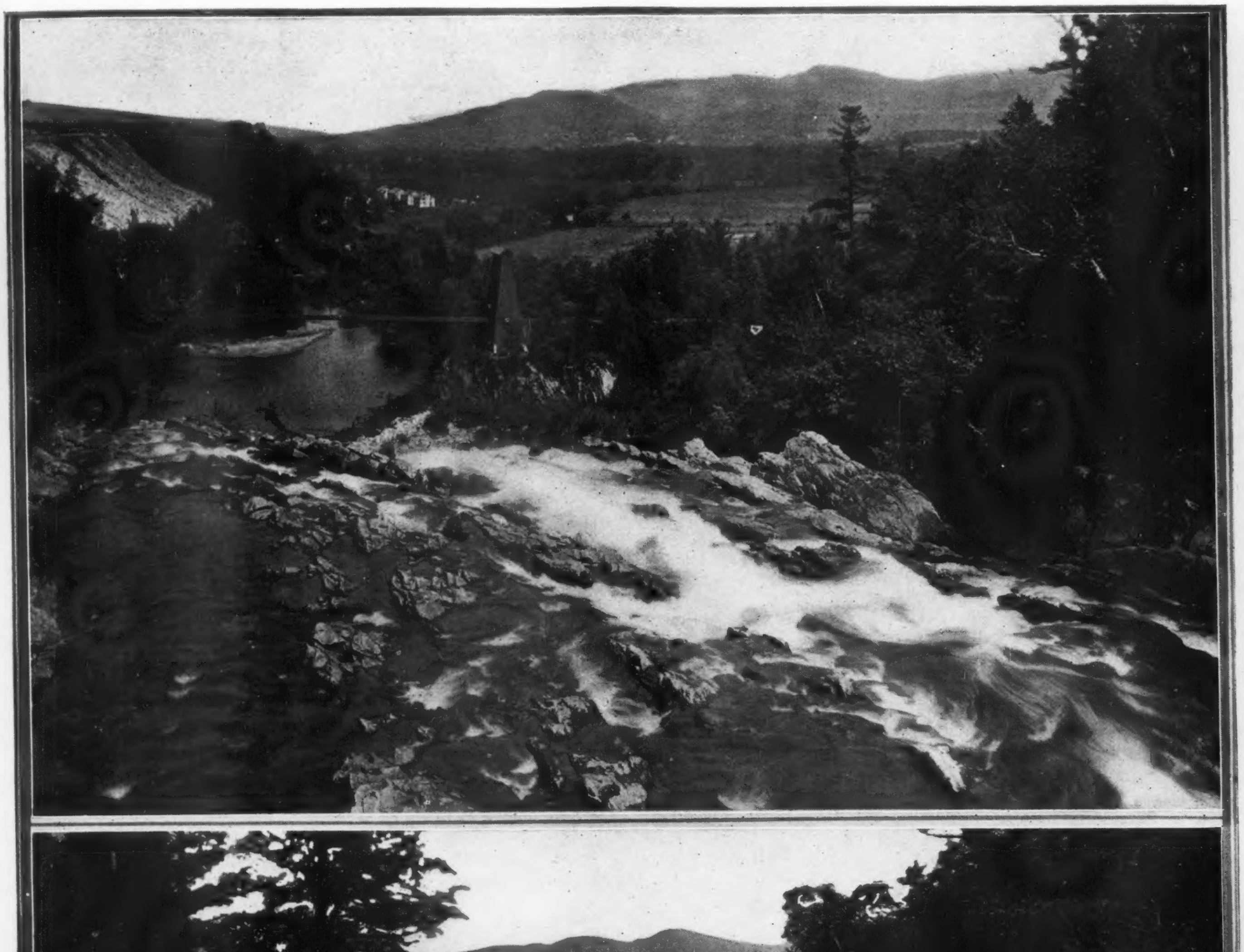
According to the geologist, at some period during the presence of that sea, marine currents swept on to the rocky waterbed accumulations of sand carried thither from eroded ledges; and when this action ceased in the course of time, and the waters cleared, then the sea became alive with myriads of crustaceans which ranged from primitive diminutive creatures to well-developed and fairly large marine snails. All these forms of animal life took lime, held in solution in the sea, wherewith to build up either their body structures or to form the shells which served them as protective coatings. The lime so utilized had its source in limestone that probably reached the sea through the dissolving action of rain water made corrosive by carbonic acid absorbed from the atmosphere. The rain water penetrated limestone lying above the sea; dissolved the lime; and then carried it into rivers and streams that poured their floods into the ocean.

During a period that may have represented thousands upon thousands of years, the lime-using creatures mentioned died and settled upon the sea floor. This process continued until there was left upon the seabed a blanket of carbonate of lime that attained an ultimate thickness of quite 2,000 feet. In some instances the limy structures of the dead creatures were fossilized and preserved in their original form, while in other instances dynamic or chemical actions destroyed the structural forms and turned them into a granular precipitate. In either case, the carbonate of lime was gradually solidified by the pressure of overlying water and the dead weight of accumulations of sand and clay which were laid there when the waters became muddy again following the era of marine life. In the course of many centuries, the overburden of sand and clay acquired a thickness of 2,500 feet. In the end, the underlying precipitate of lime became limestone. So far, so good. Now let us see how that limestone was metamorphosed into marble.

It has been demonstrated in the laboratory



The great plant at Proctor which has evolved from a small mill. Proctor, now a township with a population of 2,900, was incorporated as a village in 1884 and named after Redfield Proctor in recognition of his efforts in placing the marble industry of the state on a stable basis.



Energy is drawn from Otter Creek at five points to furnish thousands of electrical horsepower for service in the mills and quarries of the Vermont Marble Company.

that limestone and chalk, when packed tightly in a gun barrel that is sealed, can be transformed into marble if exposed to a suitably high temperature. That is to say, heat sufficiently high or heat applied over a suitable period will cause granular limestone to assume the characteristic crystalline structure of marble without undergoing any change in chemical composition. What were the circumstances which induced the heat needed to alter the limestone, lying deep beneath the sea, so that it would become the marble of modern commerce? The explanation offered by the geologist is a simple one.

Moving a great block of marble from the storage yard into the mill for cutting and finishing.

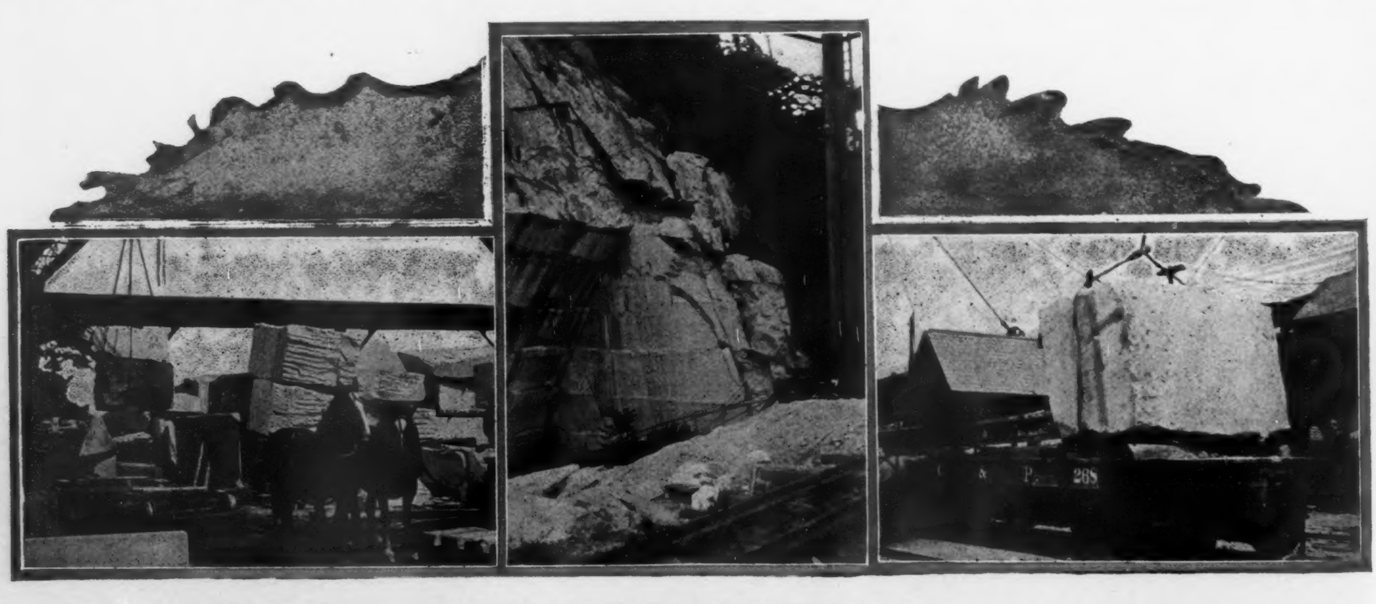
After the final blanket of clay and sand had been laid over the bed of limestone created by the accumulation of countless dead crustaceans, the crust of the earth in that section of the globe cooled and contracted; and the submerged limestone was caught between the compressive movement of the shrinking crust and the overlying vast burden of clay and sand nearly half a mile thick. The forces set up by the contracting crust were irresistible—the seabed was, in effect, caught between the jaws of a closing vise and with no path of escape except upwards. Thus was brought into being in the raw state the mass we now know as the Green Mountains, as well as the lesser ranges and hills in the vicinity. Squeezed laterally by crustal shrinkage, and pressed downward by the overburden, the limestone was subjected to a resulting heat that was high enough to change the limestone into crystalline marble; and the heat and the pressure combined were such that the marble was actually made to flow and to assume wavelike formations and, in some cases, to become enfolded. It is these undulations of the various strata of marble that the quarryman now follows as he penetrates farther and deeper below the surface of the ground.

The contending forces that gave birth to Vermont marble as we know it now imparted to the material greater strength than its parent, limestone, possessed. Also, because of the throes through which the marble passed at that time, it acquired added powers of heat resistance; it became far less pervious to water; it became strong enough to undergo measurable deformation without fracturing; and, finally, it assumed a structural get-up that makes it possible to give the stone a high polish.

The slow crustal movement that transformed the calcarious beds into crystalline dolomite and calcite marble, wrought equally profound changes in the sedimentary sands, clays, and shales: the sands and sandstones became quartzite, while the clays and shales became mica schist—each acquiring a durability which had not been characteristic of it before. Now, the questioning mind will ask, How were the strata of marble and dolomite—dolomite being virtually marble with an added ingredient in the form of carbonate of magnesia—brought to the surface of the ground so as to reveal their presence to the pioneers in Vermont? This process of uncovering the deeply buried marbles was active over another long period of geological time.

As soon as the rocky surface of what we now call the Green Mountains emerged from the sea, atmospheric erosion began its work of alteration. Gradually, the exposed rock was cut and scored by the joint actions of the atmosphere, rains, and torrential streams; and eventually the wearing away of the superposed rock reached a point that uncovered the marble beds; and these beds in some places were similarly worn away until the underlying dolomite lay bare. And now we come to the final and comparatively recent geologic date when the whole region in question was buried beneath a great sheet of ice.

This formation, when in retreat, split up into numerous titanic glaciers that, as they worked their way down hill, added to the erosive effects of earlier forces. The glaciers ground the rock they encountered into boulders, pebbles, and sand; and as these mountains of ice traveled onward they often pushed up before them great aggregations of this detritus which served to create dams across valleys. Into these basins poured the torrential streams that had their sources in the melting ice; and thus came into being many of the lakes now existing in Vermont. Fortunately, some of the glacial drift was swept on to the previously bared

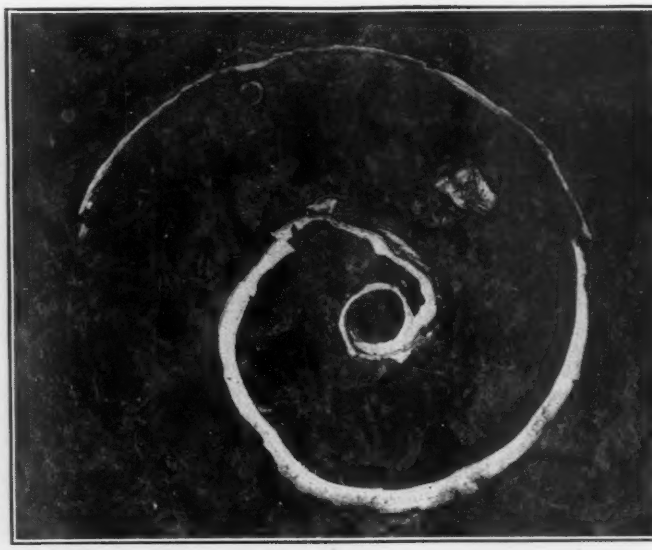


Left and right—Snapshots in the yard at Proctor.
Center—Entrance to the Hollister Quarry.

Quarry at Roxbury, Vt., from which is obtained very beautiful verd antique marble.

strata of marble; and this covering, in its turn, protected the marble beds from further erosion. We shall see later on, when we come to deal with the processes by which marble is treated in the Vermont mills, that sand drawn from deposits of glacial drift plays an important part in giving the marble its ultimate form or finish.

While most of the marbles quarried by the Vermont Marble Company are of the calcite group, still the term "commercial marbles" applies in Vermont to both those of calcitic and dolomitic origin. Therefore, as a matter of broad interest, it might be well at this point to explain the difference between the two geological formations. Dolomite is supposed to have been formed by the chemical action of sea water in substituting magnesium for part of the calcium originally existing in a deposit of calcium carbonate, or the dolomitization of the lime may have occurred after the limestone emerged from the sea—in which case percolating waters dissolved the magnesium and carried it in solution into the limestone while taking away from the limestone a corresponding measure of carbonate of lime. The dolomite marbles are often beautifully colored. The colors are due to the presence of other minerals carried into the marbles by water, or to the presence of minerals that were combined with the limestone during the kneading action of crustal movements and afterwards bound together in a solid mass by a process of cementation.



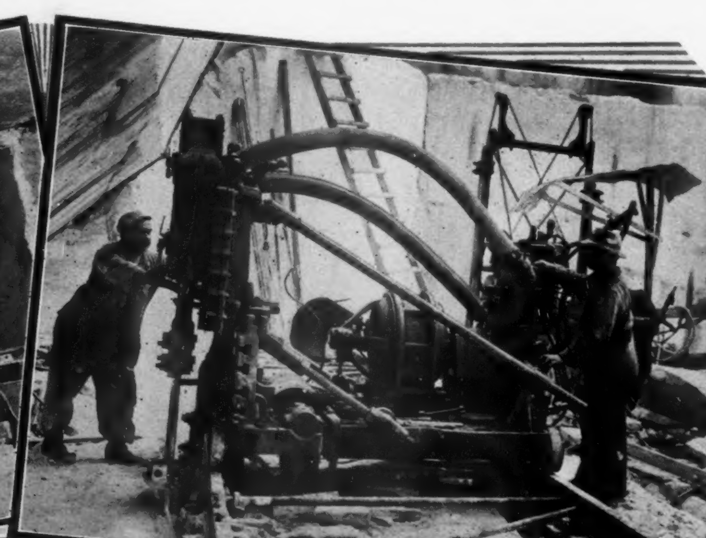
Piece of gray marble in which is preserved a cross section of the shell of a large fossilized sea snail.

Among the fifty varieties of calcite marbles produced by the Vermont Marble Company there is a wide range in coloring and in marking. Some are snowy white; others are to be had in many shades of cream and ochre; others run a wide gamut of blue; some are gray, some are green, and some are pink and red; and then there are those that are well-nigh black. In short, these marbles furnish the architect with materials that lend themselves admirably to structural applications as well as to the needs of adornment. Similarly, the sculptor has thus placed at his disposal a stone of divers hues for many purposes.

So much for the processes of Nature, in the course of amazing periods of time, by which the marbles of Vermont came into being and acquired the characteristics which distinguish them and make them so valuable today. Now let us consider those steps which gave birth to a great industry which, in its turn, has called upon engineering genius to devise ways and means by which the marble could be quarried and afterwards made ready for many different services. The story is really one of spasmodic efforts that were finally coördinated so as to put Vermont's marbles at the disposal of the many instead of the few.

No one now knows when Vermont marble was first placed on the market. On the other hand, there is plenty of evidence that marble hearthstones were used by Vermonters before the days of the Revolution. More than likely the marble first sold was in the form of slabs broken from outcropping ledges and used in fireplaces where the stone stood heat without cracking, and pleased the housewife by reason of its glistening whiteness. Sometime prior to the Revolution, one John Sutherland, journeying northward on the military road leading to Canada, halted on Otter Creek at a point known as Sutherland Falls and within the present town of Proctor, Vt. Sutherland built a sawmill and a gristmill at the foot of the falls, utilizing in a small way the latent energies of a stream that now is dammed at five places to furnish thousands of electrical horsepower.

About Sutherland Falls developed a settlement; but for generations none of the citizenry realized that there was a treasure house of natural riches within easy reach. No one dreamed of the economic possibilities of the outcropping marble that pricked through the earth that covered the adjacent valley. After nearly a hundred years of unsuccessful endeavor to utilize Vermont marble in the upbuilding of a stable industry, along came Redfield Proctor in 1870; and his organizing genius completely altered the outlook. Where the marble trade had previously been handicapped because of a lack of suitable machinery and means of transportation, Redfield Proctor succeeded in connecting Sutherland Falls with the nearest railways. Furthermore, he introduced modern machinery and transformed a slipshod mill and a half-developed quarry into sources



Left—Type of electric-air channeler which has virtually revolutionized the work of getting out blocks of marble from the quarries in Vermont.
Right—An example of what is termed "flat cutting." A swing-back channeler at work in one of the quarries.

Fig. 1—Two "Jackhamers" operating in unison from a special mounting that enables them simultaneously to drill two gadder holes in the marble.

Fig. 2—Two "Jackhamers," held in a twin mount, supported by a 3-inch quarry bar while drilling a line of lift holes at the base of a face of marble.

Fig. 3—Two air-electric Temple drills, mounted on quarry bars, making vertical shearing cuts in a marble face.

Fig. 4—Two 7-inch air-electric channelers cutting vertical slots or channels at the rear of what will later on be a line of marble blocks.

Fig. 5—Here we see how steel wedges are driven into the gadder and the lifter holes to break free a block of marble—a channel having previously been cut at the rear.

Fig. 6—A 7-inch air-electric channeler operating up and down a floor having a gradient of 35 degrees. The car at the right is loaded with cast-iron bars, runs on a separate track, and serves as a counterweight for the channeler.

of profit. In brief, he brought the Vermont Marble Company into existence—a company that now operates 75 or more quarries that have a combined yearly output of about 1,000,000 cubic feet of marketable marble. What this means can be better understood if we recall that for every cubic foot of marble sold something like five to seven feet are quarried.

Possibly we can obtain a better idea of what Redfield Proctor started well on its way and others have carried forward with the same vision and administrative skill, if we summarize some of the outstanding facts and figures in connection with the activities of the Vermont Marble Company. To this end, the following particulars are cited:

Land owned by the company in connection with its marble business	26,500 acres
Floor space of shops and mills	27 "
Depth of deepest quarry, more than	370 feet
Grades and varieties of marble produced	50
Weight of average block quarried	15 tons
Largest block ever quarried	63 "
Number of blocks quarried annually	21,000
Quarrying machines used in getting out marble	250
Pneumatic tools used in getting out and in finishing marble	450
Number of gang saws used in cutting marble into blocks and slabs	399
Rubbing beds in mills	105
Polishing machines in mills	107
Turning lathes in mills	32
Hydro-electric energy generated for use in plants	12,000 H.P.
High-voltage transmission lines	80 miles
Railways connecting quarries and mills	25 "
Employees	3,050
Board feet of lumber used annually in boxing marble for shipment	6,500,000

To most of us, a quarry is an open pit in which activities are either hampered or halted during a northern winter season. In the Vermont Valley, a great deal of the marble is quarried underground where work can be pursued the year round. Subterranean quarrying was forced upon the Vermont Marble Company because of those crustal movements in the dim past that tilted, bent, and even folded the marble beds which were originally in a horizontal position. In the case of one of the quarries in the Rutland district, the workings have already reached a depth of more than 370 feet; and in another quarry, also deep in the ground, there are galleries or rooms that extend horizontally a matter of fully 2,100 feet. Many of these cavernous quarries are impressively picturesque, and show what modern equipment has made possible and profitable in reaching into the very bowels of the earth.

(To be concluded.)

Glimpses of Burlington, the business center of Vermont's marble industry.

NEW REFRACTORY CEMENT AND SUITABLE GUN

A REFRACTORY, plastic cement—called "Carboplastic"—has been introduced recently by the Carborundum Company of Niagara Falls, N. Y. In addition, a new type of portable cement gun has been especially designed for its application. As the principal ingredient is carborundum, mixed with a suitable bonding material, a substance is obtained having both the refractory properties of carborundum and the consistency of ordinary cement.

"Carboplastic" is used for locally coating fire brick—in other words, to protect fire brick against flame impingement and against the formation of cavities caused by cracking and spalling. It is said that a coating of this kind, applied either hot or cold, will materially increase the life of furnace settings.

One of the features of the gun that will appeal to an operator is its lightness. It weighs but 12 pounds. Furthermore, a single valve controls the flow of the cement: there are no other movable parts to the mechanism. Compressed air at a pressure of 100 pounds can be used to operate the gun, which has a capacity of about 100 pounds of "Carboplastic" per minute.

SORTING CIGARS BY ELECTRICITY

THE sorting of cigars is customarily done by sight, according to the shade of their coloring, into no less than 30 separate grades. To do this work successfully requires a trained eye and long experience. Even then the decisions are often questionable. But now we are told by the *Journal of the American Institute of Electrical Engineers,* that an electrical cigar-sorting machine has been perfected that is both accurate and reliable.

The device, so it is said, automatically picks up each cigar and holds it up to its eye, which in this case is a photo-electric cell. The various shades of color cause corresponding electrical reactions, and the discriminating current directs the cigars to the compartments where they severally belong. There seems to be no way of bribing the machine, and the cigars are honestly graded at the rate of 60 a minute.

As most of us know, industry in the United States is fast becoming electrified. Even so, it is interesting to learn that, according to a recent estimate made, 65 per cent. of the power used for industrial purposes is electrical. The iron and steel industry leads in the consumption of current, even though it is only 54 per cent. electrified.

Opinions on Oil-Electric Locomotive

Expressed by Engineers at the Recent Oil Power Conference

THAT the oil-electric locomotive has aroused keen interest among engineers is evidenced by the discussions during the Oil Power Conference Week of April 19 to 24. During that week there were held throughout the country approximately 130 meetings sponsored by the leading engineering and scientific societies, including the American Society of Mechanical Engineers, The Society of Automotive Engineers, The Petroleum Institute, and other engineering bodies. At those meetings, engineers of prominence discussed the oil engine and its place in our economic life.

In reviewing the importance of those meetings and the value of the information gained by the professional men who attended, L. H. Morrison,* who was a member of the executive committee handling the Oil Engine Conference, stated that, "while both marine and stationary oil engines were subjects of many of the meetings, the application of the oil engine to railroad service was the basis of the most important of the discussions. It was apparent," so he said, "that this form of motive power is being very closely scrutinized by railroad executives, locomotive-building companies, and oil-engine designers."

According to Mr. Morrison, "the oil-engine locomotive is by no means a new invention, as generally understood by the public, for as early as 1904 an internal-combustion engine was applied to a locomotive by Daimler. That the innovation came to little, was due to the system of transmission of the power from the engine to the wheels.

"Somewhat later, other European builders constructed locomotives in which that type of oil engine was connected to the wheels by hydraulic devices and by mechanical gear trams. All these had the drawback of being cumbersome or of giving a slow torque when it was necessary to put the train in motion, whereas it is at the moment of starting, when the inertia of the string of stationary cars must be overcome, that a high torque or pull is necessary. It is incorrect to state that a mechanical, step-geared transmission cannot be successfully developed, nor can it be said that hydraulic transmission has no possibilities. Nevertheless, the electric-transmission system, while expensive, does give to the oil-electric locomotive the starting characteristics that are so desirable and which have up to now been the means whereby the steam locomotive has held supremacy. By using the engine to drive a direct-current generator which, in turn, supplies current to the locomotive driving motors, the torque at the wheels varies inversely with the speed. On starting, the torque is large enough to move about any string of cars, and when the train is being accelerated the torque decreases with the speed. The electric system performs automatically the cycle of events which in a steam locomotive is brought about through the action of the engineer in using the latest possible cut-off upon starting and shortening it as speed increases. In the steam engine, however, to avoid slipping of wheels, it is necessary to throttle the steam at the longer cut-offs—in other words, the full power of the locomotive is never available."

Continuing, Mr. Morrison said: "The railroad engineer is convinced of the ability of engine builders to design an engine suitable for use in a locomotive frame. Contracts, already awarded, prove that railroad managements realize that such units are decidedly superior for switching services. This is, of course, a large sphere; but it does not by any means constitute the main field of usefulness in which the oil-electric locomotive will ultimately preponderate.

"Many who are not familiar with thermodynamics assume, inasmuch as modern central stations are developing a horsepower-hour on one pound of coal, that the steam locomotive is equally susceptible to an increase in efficiency. While higher steam pressures, as well as stage-feed water heating, air preheaters, and other accessories, have occasioned some increase in thermal efficiency, the real advantage of the power-plant turbine over the locomotive is that the former operates condensing while the locomotive has an atmosphere exhaust. As there is as much power in the expansion of a pound of steam from zero gage to —13.5 gage as is obtained in the expansion from 135 pounds gage to zero gage, the advantage of the condenser is obvious. It is, of course, possible to use a condenser on a locomotive, but this would be not only expensive in the first place but would also entail a large amount of wheel load unavailable for tractive effort. Even if the turbine locomotive came into general use, its conversion efficiency of a pound of coal would not exceed 15 per cent. and probably would not average over 10 per cent. as compared with the present steam-locomotive practice of 5 to 8 per cent. From what has been outlined, obviously, any decided increase in the efficiency of the locomotive can be obtained only through the use of a different mechanism.

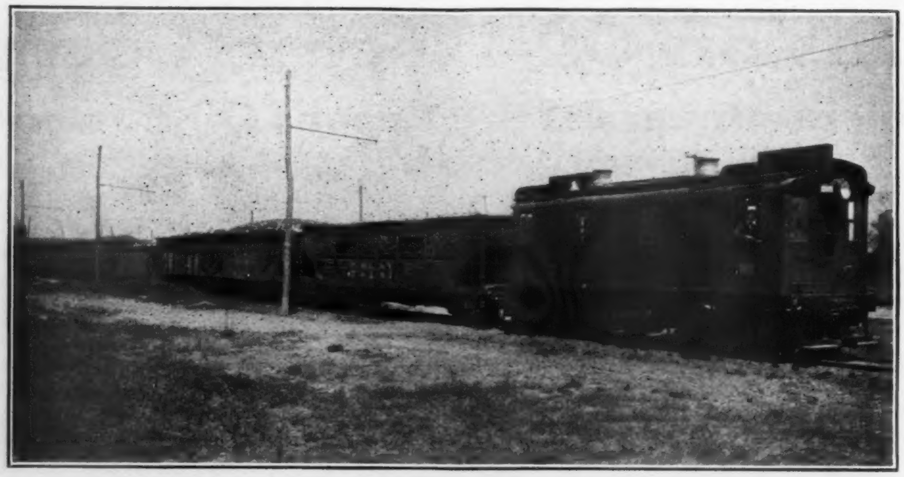
"Electrification has been adopted on several main lines; and where the traffic density is sufficient there is no doubt that the resulting economy justifies the initial investment.

"It is hardly probable that the oil-electric locomotive will successfully compete with the electric locomotive on such main-line service,

*Secretary, Oil Power Division, American Society of Mechanical Engineers and Oil-Engine Editor of "Power."

The 100-ton oil-electric locomotive that made the run of 537 miles from the shops in Erie, Pa., to New York City, for service on the Long Island Railroad, without taking on oil and water during the trip. As might have been expected, this new and economical type of locomotive has awakened much and widespread interest in engineering and railroad circles.

for while the efficiency of the oil-electric locomotive is approximately 25 per cent., and that of the electric locomotive not over 15 per cent., the relative costs of oil and coal probably make electrification the more economical of the two. Farsighted railroad executives and engine builders realize that it is in the broader field of branch lines, where traffic density is not high, that the oil-electric locomotive will be more widely adopted.


Oil-electric locomotive shifting freight cars in the yard of a manufacturing plant.

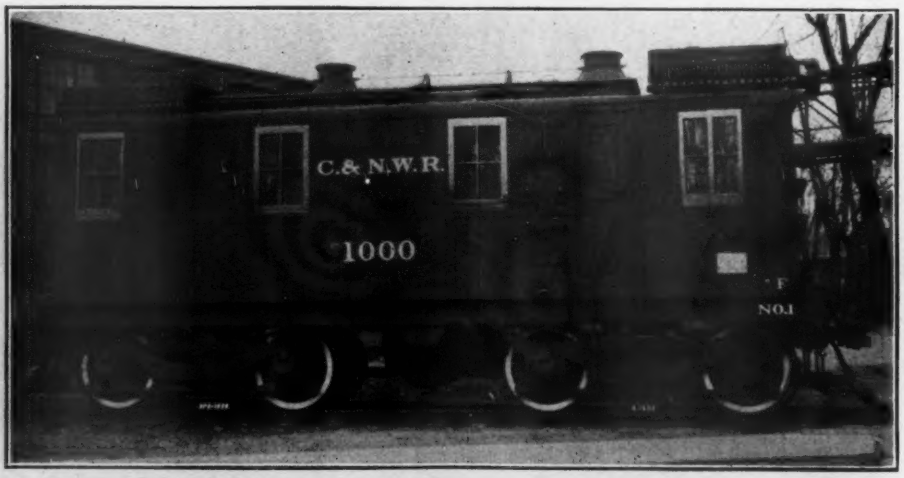
"Taking, for example, the lines radiating out of St. Louis, Mo.—there is not one that has sufficient traffic to justify electrification. Where electric locomotives are decided upon for a given division, the entire division must be equipped with third-rail or overhead electric lines, and the power-generating plant must be designed to accommodate the future growth. Inasmuch as the transmission system is costly, the change entails a vast expenditure, which present railway incomes would not justify. In addition, to obtain a maximum return from the generating plant, the transmission lines, and the substations, the entire power of the division should be electrified. This calls for another heavy investment upon which the savings would not pay a return.

"On the other hand, taking the same division, a single oil-electric locomotive—calling for no investment other than itself—could be placed in service. It could be operated in conjunction with the existing steam locomotives until such time as other oil-electric locomotives could be purchased. Such a plan enables a railroad gradually to retire its steam equipment as it becomes worn out and, at the same time, to keep the new equipment investment at a minimum.

"The doubt has been raised as to the ability of the average locomotive engineer to operate a Diesel engine. There is no question but that the older men will find it difficult to absorb the operating information needed: the younger men will acquire this as easily as they did their knowledge of the steam locomotive. Until old age or other events retire the veteran engineer, the logical procedure is to place a young man, trained in oil-engine shops, on the locomotive as helper or "fireman." To this man could be delegated the maintenance, etc., just as is done in the case of electric locomotives on several roads.

"One may logically state that the oil-electric locomotive will find the widest application upon the Western railroads. The available feed water along many of these lines is bad, and the tube replacement and the re-ending necessary as a result of improper feed entails the expense not only of replacement labor but of the maintaining of a reserve of locomotives quite out of proportion to the traffic handled."

In conclusion, Mr. Morrison brought out that, "Approximately 20 per cent. of the coal consumed by a locomotive occurs when the latter is idle either on sidings or in railroad yards. Then, of the 125,000,000 tons annually consumed by the railroads, 25,000,000 tons represents a preventable waste. Of the remaining 100,000,000 tons, the locomotive converts into use work at the drawbar not over 8 per cent—representing only 8,000,000 tons of coal-energy converted into power. As the oil engine has an average efficiency of 25 per cent. at the drawbar, and if all the locomotives were oil-engined, the equivalent in coal used would be 32,000,000 tons. Inasmuch as a pound of oil has over 30 per cent more energy in it than a pound of coal, only 23,000,000 tons of oil would be needed, or 138,000,000 barrels. This oil, at $2 per barrel, would bring the outlay to $276,000,000. When this is compared with the cost of fuel used in steam locomotives during 1925—$351,944,994, to save over $75,000,000 per year would apparently justify the use of the oil engine."



The 60-ton oil-electric locomotive, built for the Chicago & Northwestern Railway, just before making the 832-mile run from Schenectady to Chicago.

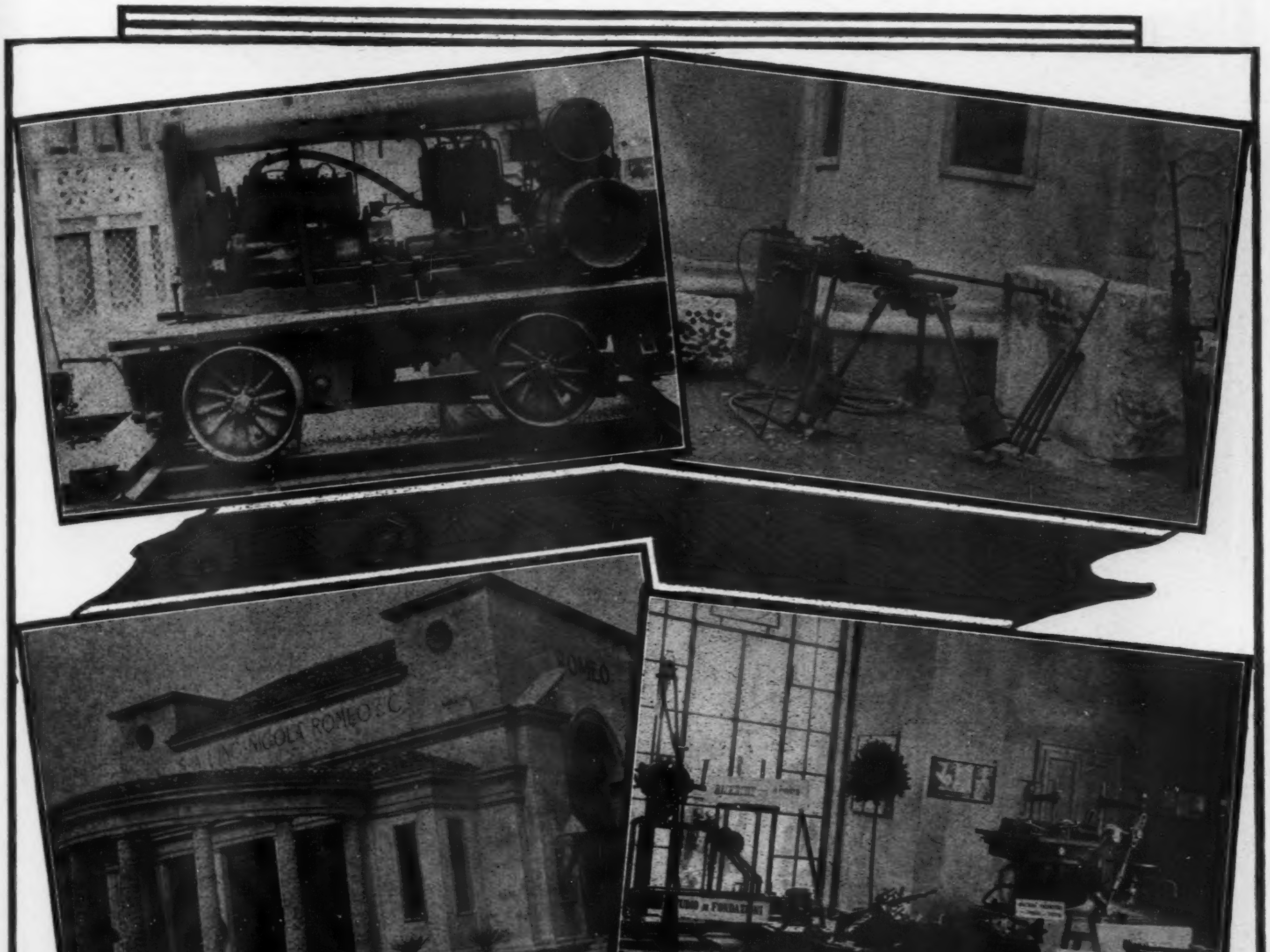
CLEANING COAL WITH AIR INSTEAD OF WATER

AT the Nordegg Collieries, Alberta, Canada, the present method of coal cleaning is to be changed—that is, plans are being made to discard wet washing and to substitute the latest system of cleaning by air. The cost involved in the change is said to be about $100,000. The air-cleaning system, so the *Western Canada Coal Review* tells us, is not to be regarded as an experiment, as the process is to be the same as that which has been in operation at the Blairmore, Coleman & McGillivray Creek mines. However, the use of the pneumatic system in the coal-mining industry is fairly new, having been introduced about three years ago; and in the collieries of the United States this system of cleaning coal is gaining favor.

By this newer method, the coal, in a thin layer, is passed over a jigging table provided with numerous holes through which air is continually being blown upward. The strength of the air current is so regulated that it will raise the lighter coal up from among the heavier refuse—the coal thus being separated and carried the length of the sloping table to the discharge end. The heavier foreign matter is guided by riffles to the side of the jigging table, where it is discharged.

In operation, the process is not as simple as it may sound. The coal must first be graded within fairly narrow limits, as the difference in the size of the pieces for each size of jigging table should not exceed half an inch. As no water comes in contact with the coal at any time, troublesome freezing resulting from the use of wet cleaning is, therefore, avoided during the winter months when the coal season is at its height.

AMERICAN MACHINERY EXHIBIT AT AN ITALIAN FAIR



The exhibit of Messrs. Nicola Romeo & Company at this year's Milan Fair attracted a great deal of attention and aroused much favorable comment because of the scope and the character of the products displayed.

Beautiful Mystic Falls that for ages formed the natural outlet of Mystic Lake.

Mystic Lake Now a Source of Power

This Has Been Made Possible by Engineering Work of an Unusual Character

By S. G. ROBERTS

MYSTIC Lake, in Montana, is situated about 45 miles southwest of Columbus, the nearest railroad point. The lake is the largest of a chain of six lakes on the West Rosebud—a tributary of the Stillwater River. The surface of Mystic Lake is at an elevation of 7,650 feet above the sea; and the watershed that drains into the lake has an expanse of 50 square miles.

In the dim past, when an ice cap covered the region, a great glacier during its descent gouged out the basin which now holds the waters of Mystic Lake. This bowl has a width of half a mile and a length of 2¼ miles—producing a superficial water area of 347 acres. In the course of its journey downward, the glacier, which started at an elevation of about 10,000 feet, scored a pathway with little impediment until it reached an elevation of 7,650 feet. There, the path of the glacier was crossed by a great granite dike; and this wall of stone successfully resisted the erosive action of the stupendous moving mass of ice. Until recently, it was over this barrier of hard rock that the waters of Mystic Lake flowed in a precipitous fall of approximately 300 feet.

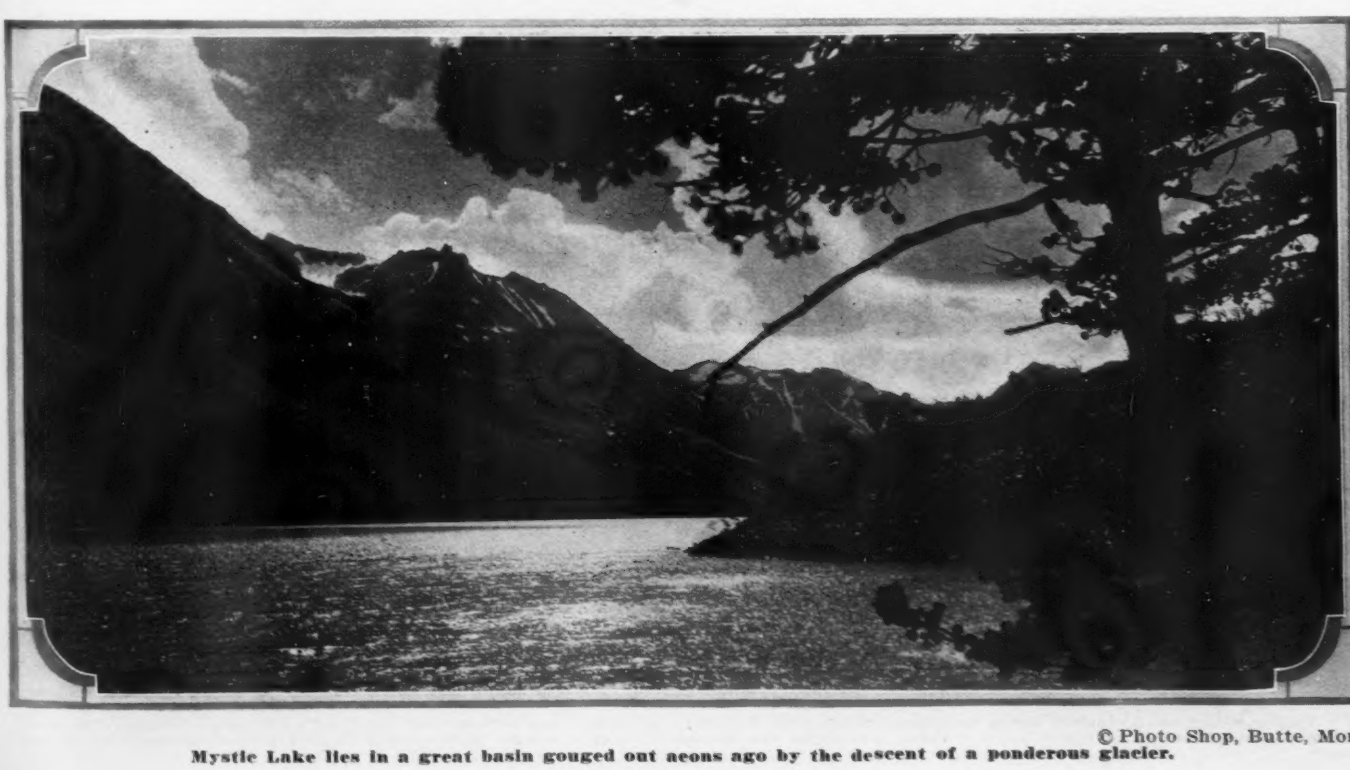
At the headwaters of the principal stream tributary to Mystic Lake there still remains impressive evidence of the time when the whole region lay beneath a great cloak of ice. This reminder of aeons gone is called "The Grasshopper Glacier"—so named because embedded in its frigid mass are myriads of grasshoppers and other insects. The origin of these insects has provoked much scientific speculation—some experts declaring them to be of prehistoric origin. The insects lie in successive layers that would seem to indicate their annual deposition. It has been plausibly explained that these creatures of the air were caught by opposing currents of air that swept them to a neutralized zone, whence they fell upon the surface of the glacier where they were quickly rendered torpid and then frozen to the ice.

As far back as 1913, the Montana Power Company investigated Mystic Lake as a possible source of hydro-electric energy for the eastern part of Montana. From time to time, to meet the growing demand within the state for electric service, the Montana Power Company called into being a number of hydroelectric plants—some of them involving engineering work of a more or less momentous character. The utilization of the waters of Mystic Lake has entailed the mastering of several outstanding difficulties; and the details that follow have been taken from a paper read before the Montana Engineering Society by Mr. M. E. Buck, General Superintendent of the Montana Power Company.

Briefly stated, the main engineering task has consisted of devising ways, and executing them, by which the naturally impounded waters of Mystic Lake could be tapped about 50 feet below their normal level and then led to a power house to be built at a point lower down on the mountainside. The utilization of the waters of Mystic Lake was decided upon after the company had considered other possible and promising sources of energy.

The annual run-off of the drainage area above Mystic Lake averages 165 second-feet. This represents a yearly precipitation equivalent to 45 inches of rainfall. As a matter of fact, the run-off ranges all the way from 40 second-feet during the winter months to a flow of 900 second-feet during June and July. The power plant has been designed to utilize at the present time a maximum discharge of 125 second-feet from the drainage area. Eventually, much water, which now escapes wastefully at flood periods into the Yellowstone River, will be conserved by constructing an arch dam, 20 feet high, upon the granite rim at the lower end of Mystic Lake, as well as by rearing other but less expensive dams at the outlets of two of the lakes lying above Mystic Lake. The Mystic Lake Dam will probably be built shortly, and by it the available storage capacity of Mystic Lake will be increased from the present 12,700 acre-feet to 20,500 acre-feet.

Broadly stated, to make the waters of Mystic Lake available for power purposes, it has been necessary to drive through rock, for a distance of 1,000 feet, a tunnel that taps the lake, and then to lead the water from that tunnel through a wood-stave pipe, 9,000 feet long and 56 inches in diameter, to a Johnson surge tank.



© Photo Shop, Butte, Mont.

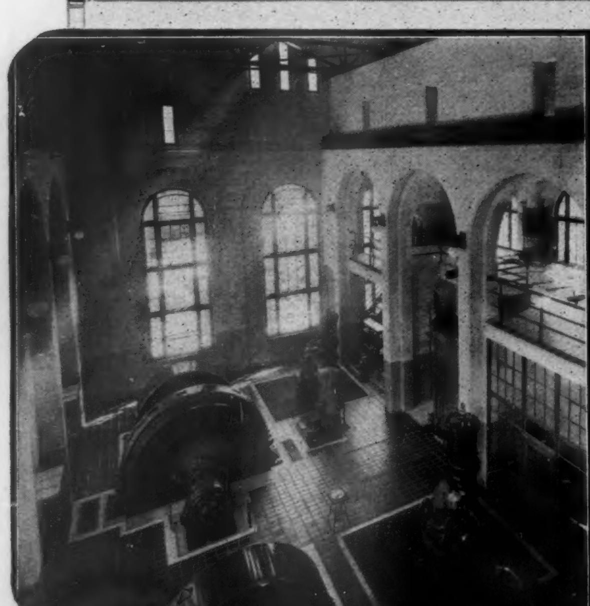
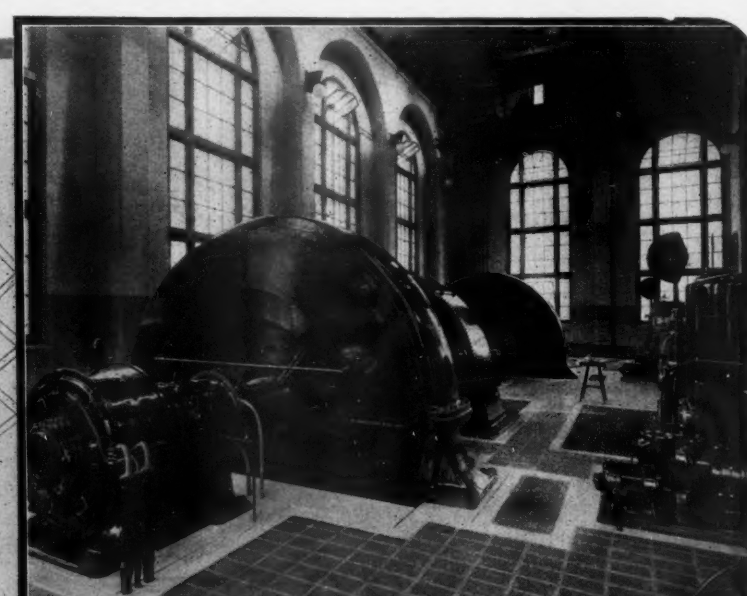
Mystic Lake lies in a great basin gouged out aeons ago by the descent of a ponderous glacier.


Left—Part of the bleak watershed of Mystic Lake in the heart of the Absarokee Range.
Right—The Johnson surge tank, at the top of the pressure-line gradient, has a height of 118 feet and serves as a shock absorber in the line between Mystic Lake and the power house.

From the surge tank the water flows through a steel penstock 2,750 feet long—the penstock delivering the water to two impulse wheels driving two 6,250-Kv.a. Westinghouse generators operating at a speed of 300 revolutions a minute. The intake end of the penstock has a diameter of 48 inches, and this pressure line is gradually reduced to 40 inches at a point 100 feet from the power house where it joins a "Y," each leg of which has a diameter of 28 inches—the legs of the "Y" connecting with the two water wheels of the generators. The operating head is 1,080 feet, making the plant one of the outstanding high-head power stations of the country.

Before any work could be done on the main project it was necessary to construct 15 miles of private roadway having a maximum grade of 5 per cent. Over this road materials were delivered to the power-house site as a base from which they were subsequently distributed along the line leading thence up the mountainside to Mystic Lake. This roadway involved an expenditure of $75,000; and all materials were moved over it to the scene of operations by motor trucks. The road was constructed by M. Bardsen & Company of Butte—work starting early in the summer of 1922 and being completed during May of 1923.

While this road to the power house was underway, a contract was let to Winston Brothers of Minneapolis, Minn., for the construction of a pressure pipe-line grade, about 2,800 feet long, to reach from the level of the power-house floor to a point 1,010 feet higher up on the mountainside—this grade to be utilized for the emplacement of the steel penstock and to provide for the laying of an inclined railroad of 3-foot gage. From the top of this incline—that is, Elevation 7,560 feet—thence up the mountain for a distance of 9,000 feet, Winston Brothers cut a bench 12 feet wide along the precipitous shoulder of the mountain. The bench has a gradient of .4 of 1 per cent. This shelf, was cut for the most

The interior of the power house is a fine example of skillfully arranged apparatus, and the two 6,250-Kv-a. generators produce 3-phase current of 6,600 volts. These machines are driven by water wheels that operate at a full-load efficiency of 85 per cent.

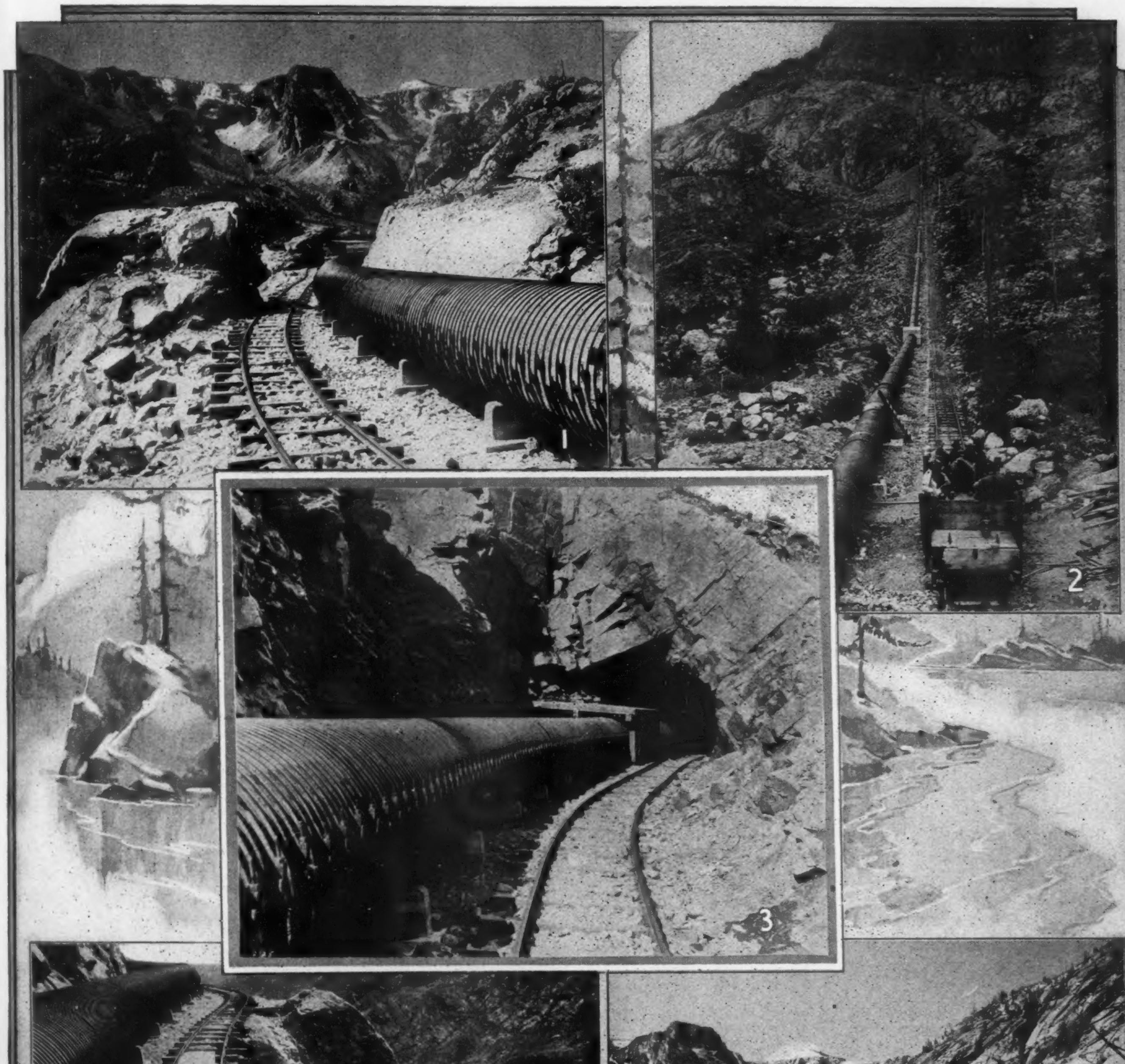


Fig. 1—Each section of this 56-inch pipe was made up of 35 wooden staves, 2⅛ inches thick by 5½ inches wide, bound together by ⅝-inch straps spaced from 3 to 3½ inches apart.

Fig. 2—Surge tank, inclined railroad, and steel pressure line leading to power house located 1,010 feet below the surge tank.

Fig. 3—Where the wood-stave pipe issues from the tunnel that taps Mystic Lake.

Fig. 4—Trackmen tightening up bolts in the bed of the railway by which supplies were moved from the operating base to the rock tunnel at Mystic Lake.

Fig. 5—A stretch of the wood-stave pipe that has a total length of 9,000 feet and cost $78,000 to construct.

**Left—The tunnel portal was driven from a point just back of the spruce tree.
Right—Drilling and blasting the bench on which the wood-stave pipe line has been laid.**

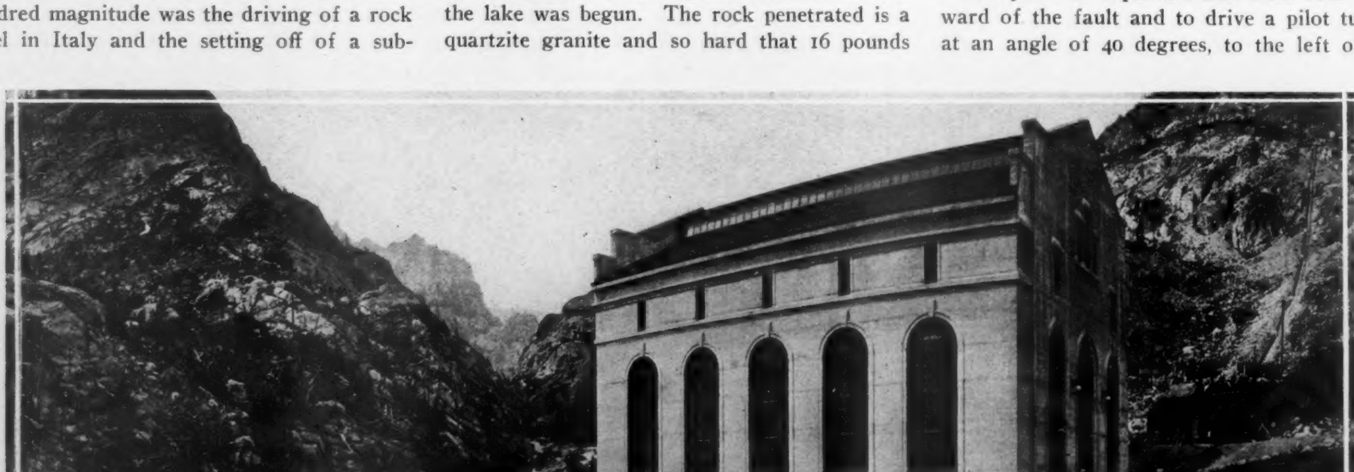
part out of solid rock and necessitated the removal of 99,665 yards of material. The bench is known as the "flow-line grade." The pipe line which follows this grade is supported by pre-cast concrete cradles spaced 10 feet apart.

From the upper end of the "flow-line grade," Winston Brothers began the driving of the 1,000-foot tunnel which pierces the granite ridge forming the barrier at the lower end of Mystic Lake. This tunnel, which opens into the lake 48 feet below the natural surface of the lake, is 6x7 feet in cross section. From an engineering viewpoint, the driving of this tunnel and the final blast by which a new channel of escape was provided for the lake's waters constitute the most important part of the whole undertaking. The only other task of a kindred magnitude was the driving of a rock tunnel in Italy and the setting off of a subaqueous blast which served to tap Lake Santa Croce in June of 1923. Conditions in the Italian project were much more favorable because there was no inflow of water to hamper the driving of the tunnel and to interfere with the placing of the explosives for the final blast.

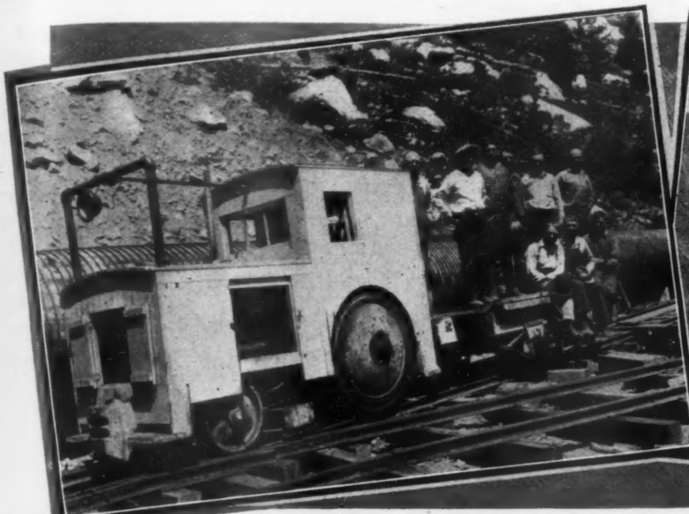
At the start, it was realized that the driving of the 1,000-foot tunnel and the blasting of an opening into the lake would be the most difficult part of the job and would, therefore, take considerable time to accomplish. Early in 1923, two small oil-engine-driven compressors were dragged by block and tackle to a point near the tunnel portal. All fuel for those compressors was transported by pack-train from the base camp. Shortly after the compressors were in place, the driving of the tunnel toward the lake was begun. The rock penetrated is a quartzite granite and so hard that 16 pounds of 80 per cent. dynamite were required per cubic yard of rock blasted—being nearly double the amount of explosive ordinarily used in such work.

Tunnel driving went forward daily in two 8 hour shifts, and an average advance of about 6 feet was made each shift. Generally speaking, the condition of the rock was excellent save where the tunnel met a vertical fault plane at a point about 930 feet in from the portal. There, water was encountered which flowed at the rate of nearly 15 cubic feet per second, and this halted progress for a while and necessitated a change of procedure.

After the situation had been examined by a competent geologist, it was decided to make a new point of departure into solid rock rearward of the fault and to drive a pilot tunnel, at an angle of 40 degrees, to the left of the



In this reinforced-concrete power house are now installed two 6,250-Kv-a. generators driven by impulse water wheels at the rate of 300 revolutions a minute.

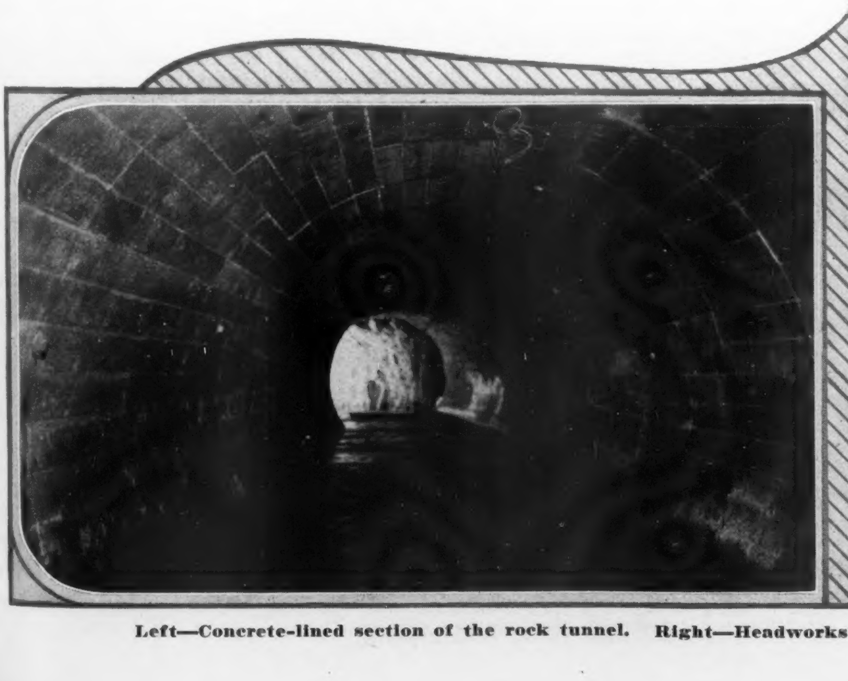
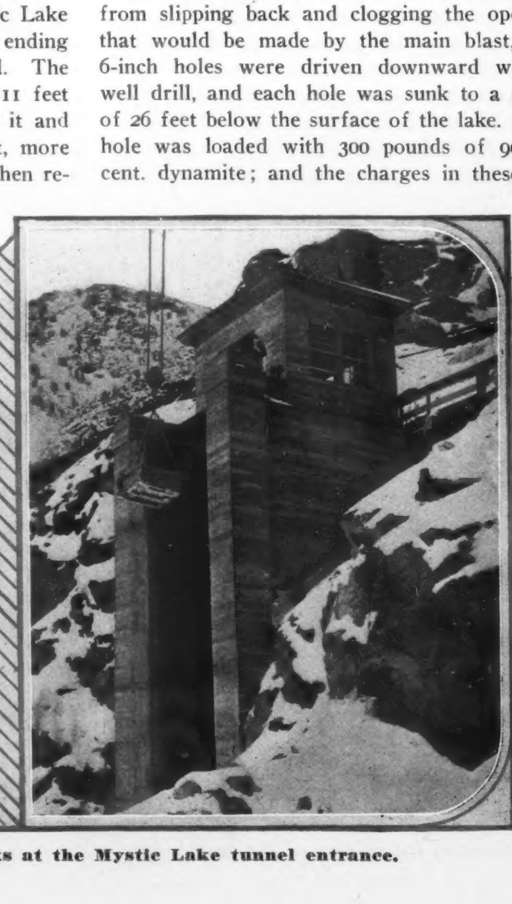



Left—Gasoline locomotive serving construction work along wood-stave line from Mystic Lake to the surge tank. Right—Car ascending the inclined railroad on a gradient of 45 degrees. Steel penstock is visible on farther side of track.

original line. When finished, the tunnel resembled in plan a narrowed "Y." Little water was encountered in this second tunnel; and it was pushed forward to within 40 feet of the lake and enlarged to full size. When the second tunnel had gone that far, two plans were taken under advisement for the further prosecution of the work. These plans were: First, to raise a shaft from the second tunnel, which might later become the operating shaft, and then from the face of this shaft to make an open cut to the lake—in this manner to lower the lake level successively by way of the shaft and tunnel as the open cut progressed; and, second, to attempt to advance the original tunnel as far as practicable toward the lake—and possibly under it—by going forward through the water-bearing fault despite the 15-second-foot flow. After reaching the foremost limit in this way, then the scheme was to blast an opening upward into the lake so as to release the water in the lake lying above Elevation 7,602. It was proposed also, that a shaft should be sunk simultaneously from the top of the ledge so that muck could be handled through it by means of a derrick already placed over the workings. This plan was finally adopted, and thus avoided the removal of muck rearward through the 1,000-foot tunnel. The original tunnel was advanced, accordingly, toward the lake; and after the water-bearing seam was passed no further troublesome flow of water was encountered.

A pilot hole was driven continually ahead of the working face for a distance of from 15 to 18 feet. This served to guard against the opening up of seams that might discharge large volumes of water, and it also enabled the engineers that were engaged in profiling the overlying cliff below the surface of the lake to check their work. In passing, it might be said that the maximum depth of Mystic Lake has not been determined—soundings ending when a depth of 183 feet was reached. The original tunnel was halted when about 11 feet of rock intervened between the top of it and the bottom of the lake. At that point, more water was encountered. The problem then resolved itself into deciding how much dynamite should be used to blast away the estimated 700 yards of rock lying between the tunnel heading and the water of the lake. The conclusion was that 6,500 pounds of 90 per cent. dynamite would be required to effect this.

Most of the dynamite used in the bulk of the explosive mass was stacked in two small pockets that were excavated on either side of the heading. From these pockets, 30 holes, 10 feet deep, were drilled horizontally and radially toward the lake—22 holes from the left-hand loading pocket and 8 holes from the right-hand pocket. Each hole was charged with 1⅛-inch standard 90 per cent. dynamite. To get rid of as much of the overburden as possible above the tunnel, so as to prevent that material from slipping back and clogging the opening that would be made by the main blast, five 6-inch holes were driven downward with a well drill, and each hole was sunk to a depth of 26 feet below the surface of the lake. Each hole was loaded with 300 pounds of 90 per cent. dynamite; and the charges in these five

Left—Concrete-lined section of the rock tunnel. Right—Headworks at the Mystic Lake tunnel entrance.

holes were set off just before the 6,500 pounds of dynamite, in the loading pockets at the tunnel heading, was detonated.

For the purpose of separating the two legs of the tunnel "Y" from one another and of sealing temporarily the lower end of the tunnel near the portal so that the tunnel could be flooded to provide a backing for the blast, three bulkheads were built at as many different points within the tunnel. These bulkheads necessarily had to be sturdy structures. With firing circuits in place and tested, the climax came when the circuits were closed at 2.40 p. m., September 25, 1924. Mr. M. E. Buck closed the switch of a 440-volt alternating-current circuit from the shelter of a gravel washing-plant about 500 feet away from the point of explosion. What occurred thereafter, Mr. Buck has thus described:

"I saw very little of the shot. I heard the explosion when I closed the switch; and through my peep hole I almost immediately discovered a large rock weighing about 500 pounds coming directly toward the barricade. At the same moment, we also saw an immense wave coming from the lake that rose from 7 to 10 feet. We had little time to choose between being drowned by the wave or being hit by the flying rock—those of us behind the shelter were undecided for only a few seconds. Happily, all went well: only one man was injured by flying particles, and he was viewing operations from a distance of nearly half a mile."

The force of the explosion shot a column of water 300 feet skyward, and as this geyser subsided the ground shook again when the delay charges in the tunnel were detonated which scattered the sand bags placed in the tunnel immediately back of the loading pockets for tamping. The next moment a whirling vortex over the tunnel indicated that a new way had been opened for the escape of the waters of Mystic Lake. The shot that had made this climax possible cost all told about $50,000. While it served the purpose intended, still the outcome was somewhat disappointing because the blasted passageway was largely clogged with broken rock drawn back into the cavity by the first outward rush of the escaping water. In short, the lake level was not immediately lowered to the extent desired. This was finally accomplished by means of an open cut 18 feet deep extending from the shaft at the left-hand branch of the tunnel thence to the lake. This shaft became the permanent intake.

Mr. Buck has said: "From our experience in draining the balance of the lake through this open cut, we felt amply repaid for the money spent in an engineering gamble, and we feel that the method adopted advanced the completion of this project by at least four months." After the open cut had been finished, and the lake had been lowered to the lowest possible level, a cofferdam was built at the outer end of the cut and work continued rapidly thereafter until the completion of the permanent intake.

In the construction of the pressure pipe-line grade; in the cutting of the long "flow-line grade"; and in the driving of the tunnel, compressed air was used extensively. Operating air was supplied by one stationary and two 8x8-inch portables—all I-R machines. Rock drilling was done with drifters and with fifteen DCR-23 "Jackhamers"; and the steels were kept in proper condition by means of one No. 25 oil furnace and three "Leyner" sharpeners.

AIR COMPRESSORS AND PSYCHOLOGY

By LARR SMIT

SIX men, the evening crew of hard-rock miners working in the Grizzly Creek power tunnel of the Feather River Power Company's project in the high Rockies, turned to leave the shaft at midnight, just as the relief crew was about due to take up its labors. Suddenly, a crash of timbers, an avalanche of talc rock, dirt, and huge boulders, and six men were buried alive. A few minutes later the midnight shift arrived at the face of the tunnel. Hearing the cries of their comrades, rescue work was started immediately.

The compressors that played a part in saving life when a shaft caved in at the Grizzly Creek power tunnel. So isolated was the scene of the catastrophe that this photograph had to be carried on foot for 3 miles, taken across a swollen creek on a raft, and transported 8 miles on a caterpillar tractor, after which it journeyed 20 miles by motor truck—the motor truck being mired three times and finally pulled out of the muck by two teams of mules.

H. V. Dardier, of the firm of Richardson, Dardier & Fontaine, contractors for the construction of the tunnel, was notified. Hours later, after 20 miles of travel by automobile truck; 8 miles by caterpillar tractor—the only motive power which could negotiate the narrow, treacherous trail of muck and melting snow and drifts; and 3 miles by foot, Dardier arrived at the mouth of the shaft. His first order was: "Start the air compressors."

Ninety hours later, after Charles McDermott had been taken out alive, saved by A-timbers, and the bodies of the less fortunate had been recovered, Dardier explained his order for starting the compressors. He said: "As a matter of fact, the compressors were useless—absolutely so. The air is used to clear the tunnel of fumes and smoke after blasting, and the air is taken to the face of the shaft through a heavy rubber hose. At the time of the collapse I knew that this hose was at least 50 feet short of the face of the shaft. I also knew that the timbers and rocks had so crushed and pinched the hose that no air could pass through it.

"My reason for ordering the pumps started, therefore, was not through any hope that it could force air to the entombed men but because I felt that the sound of the motors would break the deadly silence at the mouth of the tunnel and lend an air of activity and bustle to the scene. Its psychological effect was marvelous. According to the survivor, the sound cheered the men immensely, and gave them the feeling that nothing was being spared to aid the rescue work. So, although no air was forced to the imprisoned men, the two compressors nevertheless accomplished a great work."

CLEANING CAR CONTROLLERS WITH COMPRESSED AIR

IN preparing for the inspection of car equipment in the shops of the Department of Street Railways, Detroit, Mich., an essential detail is the cleaning of the street-car controllers with compressed air. To facilitate the work, a shut-off valve is fitted to the main air-reservoir line, which is conveniently placed alongside the controller on every car.

To this valve, a 5-foot length of flexible hose is attached whenever the work of cleaning is to be undertaken. This hose is provided with a special fitting having a long, tapering nozzle which makes it possible for the air to reach every part of the controller and to effectually remove all accumulated carbon and dust. The nozzle is also equipped with a valve, thus enabling the operator to regulate the flow of air without changing his position.

Air Hoist Lightens Work On Many a Job

By L. D. LA FORGE

A NATURAL outcome of our modern civilization has been the substitution of mechanical for human power wherever possible. Steam, electricity, and compressed air, are used in every sort of construction and engineering work not only because they are, in the end, cheaper than man power but because man, himself, has learned that machines operate faster and better, and, at the same time, eliminate back-breaking labor.

Recently, in the field of compressed air, there has been perfected a machine, the development of which is a natural response to the tendency of the times. This machine is a compressed-air hoist. Because of its adaptability, it is designated the "Utility" hoist. Inasmuch as it is economical to operate and extremely efficient, it has proved a boon to the builder, the industrial plant, and the general contractor.

It may be a broad statement to make, but it is true, nevertheless, that the "Utility" hoist can do almost any kind of pulling or lifting within the scope of its rope length and the power of its motor. A portable compressor is usually its working partner because of the variety of jobs that the sturdy portable is called upon to perform and the out-of-the-way places in which it is frequently set up.

In road making the "Utility" hoist has been of inestimable value. If the Romans could have conceived such an engine they would have greatly shortened the time required by them to subdue the countries of the then known world. This air hoist, when set up and secured to a convenient rock, tree, telegraph pole, girder, or floor within 350 feet of the object to be removed, can handle a load up to 2,000 pounds. Indeed, the elephants of India, though their reputation for clearing roadways through the thick forests has been acclaimed in song and story, would suffer by comparison, as the "Utility" hoist, weighing but 250 pounds and furnished with air at 80 pounds pressure, can haul a 1,000-pound tree or rock at a speed of 65 feet per minute.

The builder of roads has found other uses for the air hoist besides removing rock and hauling tree trunks. He has found the "Utility" helpful when he desires to lay a culvert, or to haul a scraper when leveling and backfilling. In fact, if he wishes to pull anything or hoist anything, he need but call upon this friend; and, if the demands do not exceed its power, the work is quickly done.

But the "Utility" hoist has a far wider field of usefulness than aiding in the clearing and the leveling of highways. In trench work we find it lifting heavy pipe into position and refilling the trench after the pipe is layed. If wire or cables have to be pulled through conduits it does the trick quickly and satisfactorily. The constructor has found it of great value in hoisting material to different elevations as his building progresses. Steel beams, building stone, concrete, and concrete forms, are moved with equal facility wherever required.

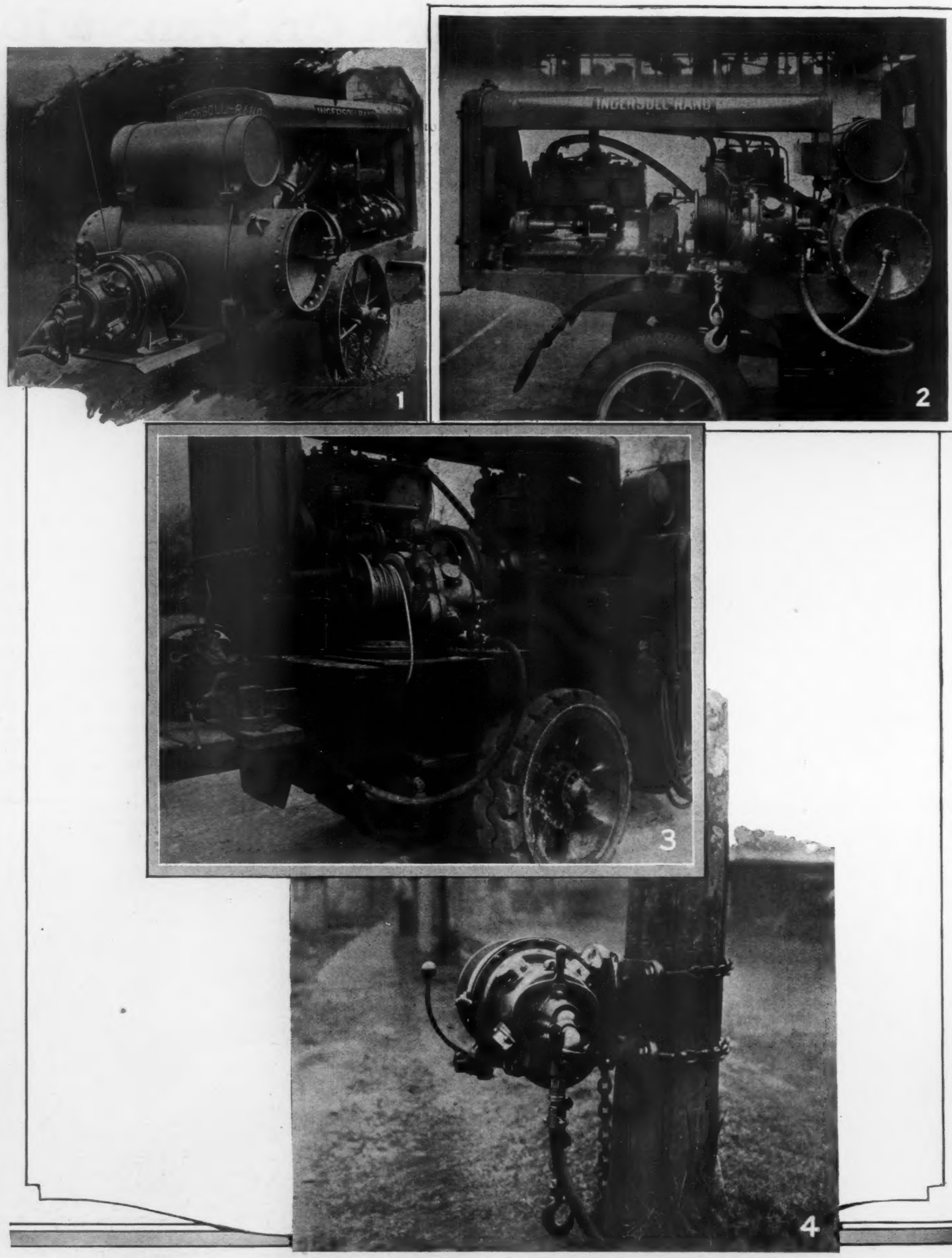
The "Utility" helps the service man of a telephone company. Everyone knows that uninterrupted telephonic communication, not only in cities, but from city to city throughout the country, is demanded in this high-pressure business age. In almost any part of the country you will find the service men putting up new poles or replacing worn wires. The stringing of these wires is made easy and is done quickly by this friend of the roadbuilder and the contractor. But the photographs accompanying this article show, perhaps better than any descriptive text, just how serviceable the hoist really is.

Sometimes the hoist is called upon to do an unusual task, such, for instance, as the pulling of drill steels from soft coral rock encountered in roadbuilding in Miami, Fla. But, no matter what the task, if it be within its power, it can be counted upon to do it well. We have mentioned the fact that wherever the portable compressor can go you are apt to find the hoist. Indeed, occasions arise when the portable, itself, must be hauled over rough places or shifted for short distances by the hoist, which the portable is operating.

A condition which contributes to the wide application of this hoist is its adaptability. For some requirements it is mounted behind the familiar 5½x5-inch portable, or one of the five larger sizes built by the Ingersoll-Rand Company. For other tasks, a Ford or a larger truck provides the base from which the hoist performs its work. But for much of its work the hoist will be found attached to whatever will hold it securely in place while handling the job.

The "Utility" hoist is not a glutton for air. A length of heavy pipe can be lifted and lowered into a trench with the power furnished the hoist by a 5½x5-inch portable compressor

Backfilling a trench with the help of the DU "Utility" hoist.



The facility with which the "Utility" hoist can be mounted on a portable compressor or secured to any convenient telegraph pole, tree, girder, etc., makes it especially adaptable for a wide variety of contracting and engineering jobs.
Fig. 1—The hoist mounted at the rear of a 5-inch stroke portable compressor.
Fig. 2—A similar compressor outfit, on a Ford truck, but carrying the hoist at the side.
Fig. 3—Side view of a heavy truck showing another arrangement of the "Utility" hoist.
Fig. 4—Close-up of hoist fastened to a handy telegraph pole and ready for service.

Drilling holes with a paving breaker in the soft coral rock encountered in roadbuilding at Miami, Fla.

which, at the same time, is supplying air to a pneumatic digger.

A feature of the hoist which is worth mentioning is the clutch. It insures the economical use of compressed air, for when the clutch is thrown out, and when the load is down grade, the cable of the hoist can be payed out by hand without the necessity of turning over the motor —a hand brake being provided to check the unwinding and to enable stopping at any desired point. The throttle control is also a desirable feature because it combines sturdiness with such sensitiveness that any desired speed of rope travel—from the slightest motion to a rate of 65 feet per minute—is obtainable even when hauling a capacity load.

The hoist is compact, and of the winch type. With a length of only 25⅜ inches, a width of 15 inches, and a height of 19⅛ inches, the drum is capable of accommodating 350 feet of wire rope, 5/16 inches in diameter. It is obvious now why the hoist proves so useful to engineers, roadbuilders, trenchmen, and contractors, in general, who are forced, as a rule, to make use of light equipment because of the shifting character of their work.

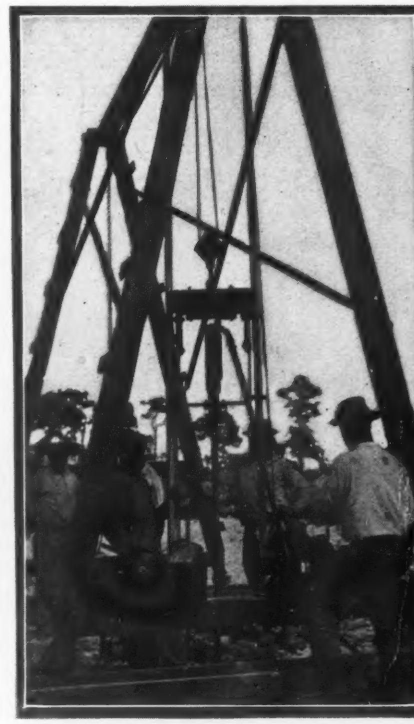
The sturdiness, compactness, efficiency, and operating economy of this hoist have added another leaf to the record of accomplishments brought about in the last few years by developers of compressed-air machinery.

DEVELOPMENT IN THE RAYON SILK INDUSTRY

WITH the rapid development of the rayon industry in Italy by the viscose process, one of the principal problems of the rayon companies has been to provide caustic soda which shall be as free as possible of sodium chloride. A number of mercury electrolytic plants have been built or are under construction expressly for this purpose.

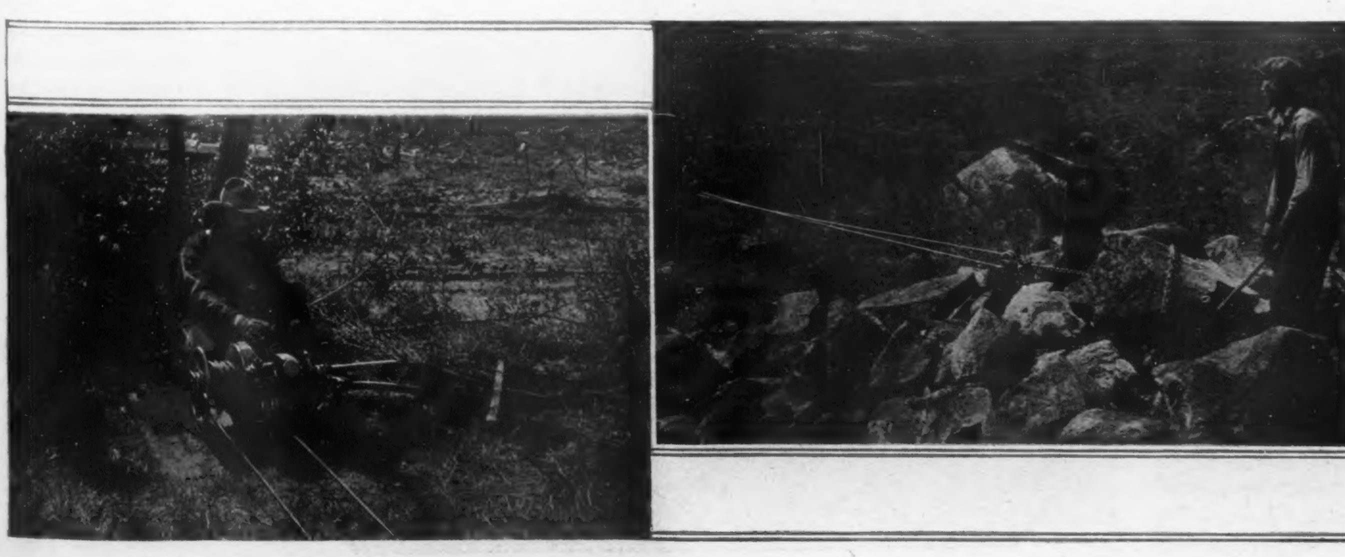
The increased production of caustic soda for the viscose factories has brought up another problem—that is, what to do with the chlorine obtained at the same time. It has been suggested that it might be used as a reagent in the processing of leucites for potassium salts and vegetable fibers. The possibility, in the case of vegetable fibers, is of great importance from the point of view of the rayon industry, itself, as cellulose is its chief raw material. For some time the Societa Elettrochimica di Pemilio has been producing a chemical cellulose by the action of chlorine on esparto grass. It has not yet been proved that cellulose obtained by chlorine processes can be used for the manufacture of rayon, but active research is being conducted in this field.

While cellulose may be considered a raw material in the manufacture of viscose silk, caustic soda may be regarded as a chemical agent, a considerable proportion of which is, theoretically, at least, recoverable. The reutilization of this product is at present the object of intensive investigation.

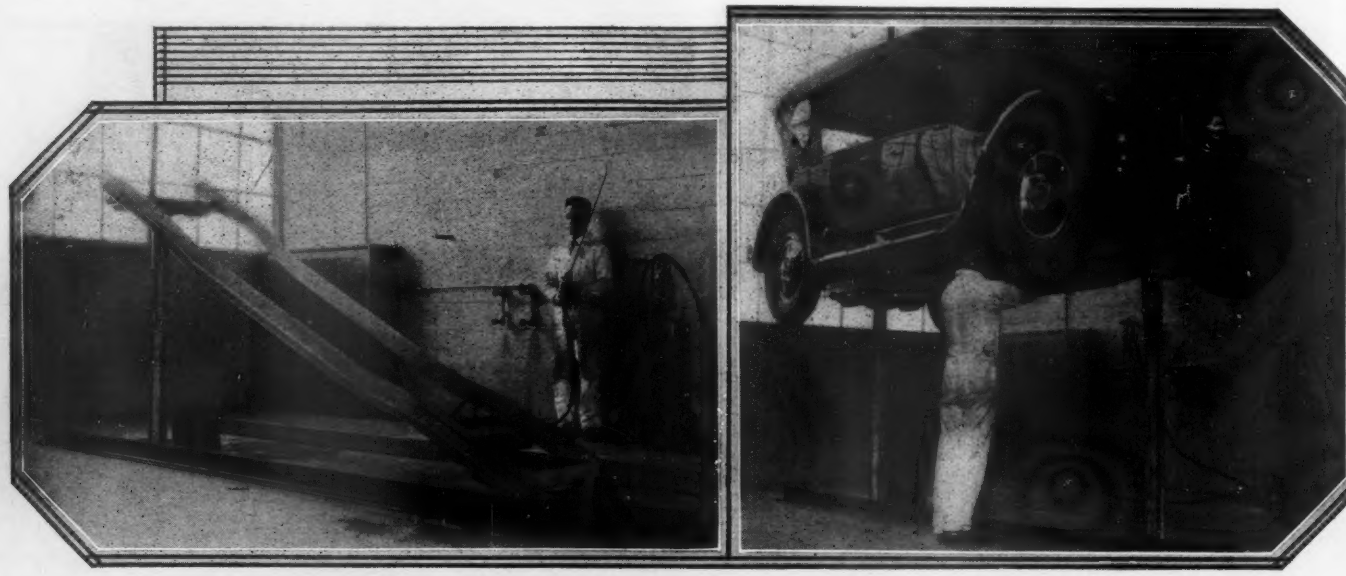


"Utility" hoist mounted on drilling rig and used for pulling out steel.

Swiss wall-paper manufacturers, so *Commerce Reports* informs us, are reported to have successfully developed a method enabling them to use aluminum in the manufacture of wall paper. The paper is made of commercially pure aluminum, which is rolled and then backed with stiff paper. The design is stamped upon the aluminum surface—the impression going through the backing paper. While the coloring and the embossing processes are said to be giving satisfactory results, the makers have not yet been able to overcome the metallic effect in the finished paper.



Left—Close-up of the "Utility" hoist on a California highway job.
Right—Removing rock by means of the air-driven hoist is part of the day's work in the building of this California roadway.



Left—Pneumatic car-elevating apparatus and compressed-air-operated lubricator. Right—Car raised uniformly at both ends to facilitate lubricating the transmission mechanism.

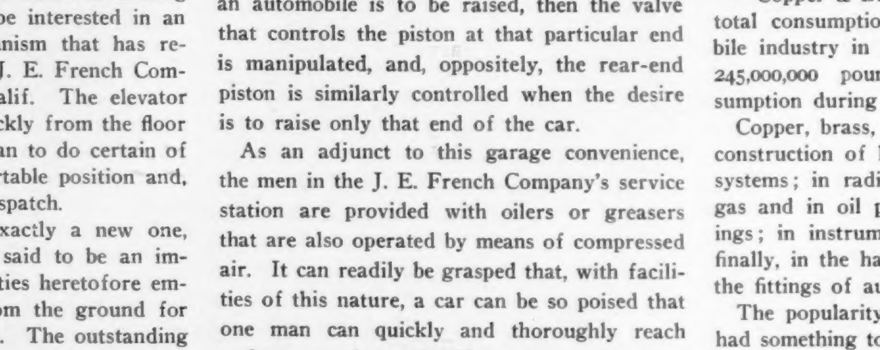
AIR LIFT LIGHTENS WORK IN SERVICE STATION

GARAGE mechanics, that have spent hours and hours lying on their backs in making necessary car repairs, will be interested in an automobile elevating mechanism that has recently been devised by the J. E. French Company, of San Francisco, Calif. The elevator is intended to raise cars quickly from the floor so as to enable the repairman to do certain of his work in a more comfortable position and, incidentally, with greater dispatch.

While the idea is not exactly a new one, the elevator in question is said to be an improvement upon other facilities heretofore employed in raising a car from the ground for the aforementioned purpose. The outstanding feature of the mechanism is a cradle, equipped with compensating rollers, which makes it possible to lift either the front or the rear end of a car, as desired.

Compressed air, which is usually available in most up-to-date garages, is used to operate the elevator. The essential parts of the device are two elevating cylinders and two underground surge chambers, all of like capacity. When an automobile is to be raised evenly, the operator opens two air valves, thus permitting compressed air—at a pressure of 115 pounds to the square inch—to flow into the tops of the surge chambers, which are filled with oil. The action of the air is to force the oil, by way of connecting piping, out of the surge chambers and into the lowermost ends of the piston cylinders. It takes but one minute for the pistons to lift a car to a convenient height for oiling or repairing. When only the front of an automobile is to be raised, then the valve that controls the piston at that particular end is manipulated, and, oppositely, the rear-end piston is similarly controlled when the desire is to raise only that end of the car.

As an adjunct to this garage convenience, the men in the J. E. French Company's service station are provided with oilers or greasers that are also operated by means of compressed air. It can readily be grasped that, with facilities of this nature, a car can be so poised that one man can quickly and thoroughly reach and grease the underside parts or do other work which he would find difficult to accomplish quickly and well if not similarly aided.



Air-operated elevator raising forward end of a car so that the pneumatic lubricator can reach otherwise inaccessible parts of the machine.

AUTOMOBILE INDUSTRY USES MORE AND MORE COPPER

ACCORDING to an estimate made by the Copper & Brass Research Association, the total consumption of copper in the automobile industry in 1925 amounted to more than 245,000,000 pounds. This surpasses consumption during any other year.

Copper, brass, and bronze are needed in the construction of lighting, starting, and ignition systems; in radiators and in water tanks; in gas and in oil piping; in bushings and bearings; in instrument and machine parts; and, finally, in the hardware forming the trim and the fittings of automobiles.

The popularity of the closed-car model has had something to do with the growing demand for copper in the industry; and present-day mechanical refinements—such as air filters, oil cleaners, central chassis lubrication, and 4-wheel brakes have also called for increasing uses of copper and its alloys.

Because of the unavoidable neglect of country roads in Germany within the past ten years and more, something like 112,000 miles are very much in need of repair. It is planned to resurface the main highways and to use a top dressing that will withstand the suction of rubber tires. In order to determine just what material would best serve the purpose, the authorities have constructed a trial road near Brunswick and have given it six different kinds of surface dressing. Contractors, generally, will be interested in the outcome of the tests.

The Red Lake Gold Rush

Canada Finds Potential Wealth in the Auriferous Deposits of the District

By HUGH RONYAN

ROMANCE in prospecting for metals is again in evidence in the Red Lake gold rush now on. There is every reason to believe that the district in question will prove a prolific source of the everlastingly precious metal.

Canada is outstandingly rich in her mineral deposits; and the discovery of gold in the neighborhood of Red Lake adds just so much more to her known store of underground treasure. During 1925, from her northern mines, Canada produced metals to the value of more than $62,000,000; and this output will probably be increased to a substantial extent by the gold that will be garnered from the Red Lake area.

The accompanying article should make a double appeal: first, because of the economic significance of the new find, and, then, because of the human and the heroic aspects of the struggle which has revealed where Nature has stored an abundant source of this precious metal.

WHEN Jason set out for Colchis in the good ship *Argo* to win the Golden Fleece, he had a tested band of heroes as his ship's company. And he needed them, for before he accomplished his task he encountered many and marvelous dangers. The quest for gold puts steel into men's hearts and redoubles the vigor in their limbs. No mountains are so high, no deserts so arid or wide, no seas so tempestuous, as to turn men from their pursuit when beckons the golden fleece. The forty-niners who faced the fevers of Panama or the alkali plains and snowy mountain passes on the way to California, the sourdoughs and tenderfeet who climbed the icy peaks and braved the blizzards that marked the trail to the Yukon, have their place in romance and story.

It would appear that only the occasion is required to reawaken the never-dying ardor which is the normal reaction of the human race to gold. In the northwestern part of the Canadian Province of Ontario—named Patricia after one of the numerous granddaughters of Queen Victoria—is the Red Lake district. The discovery there in July, 1925, of what seems to be an unusually rich deposit of gold has set the world a-tingle and started an exodus to that out-of-the-way corner which, when the snow leaves the ground and the ice the rivers and lakes, is expected to become one of the greatest gold rushes that Canada, at least, has ever seen. Gold rushes in Canada are by no means unknown. Witness the Cariboo days of British Columbia, the scramble of 1898 and succeeding years for the Bonanza and Sulphur creeks of the Yukon, and for the domes and golden stairways of Porcupine.

Yet for the first find of gold at Red Lake we must go back nearly 30 years. A company—composed mostly of wellborn Englishmen and Irishmen, called the North Western Ontario Exploration Company, Ltd., and with the Earl of Portarlington as president—sent several of its members on a prospecting tour into the wilds. They left Dinorwic, on the Canadian Pacific Railway, in the early summer of 1897; passed in their canoes through Sandy Lake, Minnitaki Lake, Lac Seul, Shallow Lake, and Gull Rock Lake, and came to a halt at Red Lake. Perhaps D. B. Dowling's description of the geology of Red Lake, published by the Dominion Government in 1894, may have been the cause of their resting there.

The party prospected for minerals, and found gold. Not alluvial gold in sand or gravel, as in California or Cariboo, but gold in veins in the solid rock. From the decomposed surface of these veins they got a good showing of colors in their gold pans. It was necessary to have their claims properly surveyed, and so they decided to return at once to civilization and to bring in a surveyor. Taking their samples with them to be assayed, and elated at their good fortune, they embarked in their canoes for the return trip. The last man was the leader of the party, R. J. Gilbert. Alas, the tragedy! Gilbert had laid his belt containing a heavy Colt revolver on the rocky shore. As he stooped to pick it up, the revolver slipped from the loosened holster, struck hammer down, and the bullet pierced Gilbert's body, killing him on the spot. He was a big, powerful man, and the weather was hot; but with wonderful courage his companions took his body all the way back to be laid among his own folk. One can imagine something of the pathos of that journey.

Reaching home, they engaged a surveyor; retraced their 200-mile canoe trip; had their claims surveyed; established camp; and continued throughout the winter to develop their find. The assays ran from $2.60 to $12.50 per ton; and there were numerous outcroppings showing gold. The party contented themselves with laying out eight claims only. But the difficulties of the situation were too many for even those stout Britishers. The distance from the front, the heavy cost of transporting supplies, and the impossibility of taking in machinery, brought the enterprise to a close.

There is a curious sequel to this story. The surveyor who laid out the claims was J. W. Tyrrell of Hamilton, famous in the annals of Canadian exploration. In the month of March, 1926, Tyrrell's son and a companion named Farewell flew in an airplane from Hudson Station to Red Lake; and, guided by the old field notes, restaked the abandoned claims. In 1897, when the discovery was made, Red Lake was part of the territory of Keewatin, administered by the Dominion Government. In 1912, Keewatin was divided between the provinces of Ontario and

Left—The first certificate of record at Red Lake was issued to Jack Hammell. Jack Hammell at right of line.
Circle—"Snow motors" that did not measure up to expectations as tractors.
Bottom—The airplane has been extensively used for transporting passengers and materials.

Manitoba, the Red Lake area being in Ontario's share. Hence the mining law of Ontario now regulates the staking of claims in that district.

Wandering prospectors found gold and also silver in the region in 1922 and 1923, but the veins were small and apparently not of great value. However, a few claims were staked, and in 1922 and also in 1923 the Ontario Government sent in a geological party, under Dr. E. L. Bruce, to make a closer examination. Bruce's report and map, published in 1924, were eagerly scanned by prospectors, trained in the Porcupine and Kirkland Lake gold fields, who recognized the geology as favorable for the occurrence of gold. So the Howey brothers, Lorne and Ray—skilled prospectors from the Kirkland Lake gold camp who appreciated what Algoman intrusives and porphyry dikes in contact with granite or Temiskaming sediments meant in relation to gold—followed in Bruce's steps; and where that conscientious investigator saw only geology they found gold. Tracing up a stringer, they suddenly came upon a vein 8 feet wide in some places and 40 feet in others, with gold showing all through. The brothers looked at each other, and tears stood in the eyes of both. Lorne tells the story: "Looks like we got it, said I to Ray. 'Ain't that what we came for?' retorted Ray, and he turned his head away and darned near cried out aloud."

Staking out twenty-two 40-acre claims, they hastened to Kenora to record them.

At Kirkland Lake the brothers had been associated with a well-known mining man named Jack Hammell, and to friend Hammell they told the news. It was late in the autumn of 1925, when ice might form at any time on the lakes and rivers and hermetically seal up the infant camp; but Jack Hammell was equal to the occasion. Assembling his men and provisions at Hudson, he succeeded in obtaining the use of the government forestry service airplanes that were just completing their patrol for the season. So what with canoes and what with airplanes, Hammell got his workmen and food supplies on the ground before the freeze-up.

Stripping the find of its overburden of earth, and digging trenches across the formation, the party had exposed the showing sufficiently by the middle of January to enable an estimate to be made of its promise. But let Hammell himself sum up the find. "We have three alternatives. First, if we want to mine over widths of 10 or 12 feet, we can mine ore that will average \$50 to \$75 per ton; second, if we desire to make a medium-grade mine, we can mine medium-grade ore over a width of 50 feet; third, if we want to mine low-grade values on a huge scale, we can mine ore over as much as 66 feet. We actually have commercial values across a width of 66 feet. The vein has been opened up for 1,200 feet in length, and is just as strong at east and west as it is at any intermediate point."

Hammell's next move was to interest a mining organization with sufficient capital and enterprise to take over the property and make a mine of it. It was no poor man's job. But it is a fact that successful mining companies recognize that, at the best, a mine is a wasting asset, and are therefore always on the lookout for new mines to open and new fields to conquer. Armed with assay sheets and technical data, Hammell easily obtained a hearing from Dome Mines, Ltd., which operates the well-known Dome gold mine—one of the "big three" at Porcupine. Dome sent its engineers and geologists, headed by "Doug" Wright and John Reid, to study the prospect. They thoroughly checked up all the work that had been done and reported favorably; and a deal was made by which the Dome company took an option on the Red Lake Howey claims, paying \$50,000 in cash and the right to purchase a 75 per cent interest in a \$5,000,000 company for \$450,000. The prospectors and Hammell retained a quarter interest.

News such as this was all that was needed to set the heather on fire. Hudson, the point of departure from the Canadian National Railway, is a little flag station about 15 miles from Sioux Lookout, which is close to the junction of the Fort William branch and the main line. At Hudson there was absolutely nothing but a

Top—The station at Hudson has been the jumping off place for Red Lake.
Bottom—Tractors preparing to haul freight to Red Lake.
Right—On the Howey claims: trench dug to show up gold deposit.

Camping in this country is full of difficulties; and all supplies must be moved into the region.

small station, a Hudson Bay store, and an old hunting lodge now transformed into a "stopping place." Out from Hudson sped the prospectors—the race being to see who could first stake out claims nearest to the Howey group. Deep snow covered the chain of lakes forming the route to Red Lake. Only dog teams could negotiate the journey. Two to five huskies in a row, according to the load, trailing toboggans piled with supplies and equipment, dotted the long 130-mile trail—the men traveling ahead, to break the way for the dogs, or mushing behind.

This may seem a romantic method of travel, but in reality it is gruelling work, fit only for the strongest and the hardiest. The temperature 20, 30, or even 40 degrees below zero, blinding blizzards piling up the snow on the scarcely discernible track, snow blindness, and the extreme of fatigue, call for every ounce of endurance that the human constitution can muster. With the weary day's journey ending when the short winter day begins to wane, camp must be made, and preferably in the shelter of a clump of trees. Snow shoes are used to clear away the snow; cedar boughs are laid, curve up, on the ground to form a bed; and a fire is lit and supper prepared of bacon, biscuit, and tea. The dogs must be fed on fish, if fish is to be had, otherwise on cornmeal porridge and tallow. The welfare of the dogs is as important as the health of the men. The true husky does not freeze: he curls himself up in a circle, burying his nose in his warm coat of hair and gathering his toes under his body. As a result of the gold rush, the price of good dogs rose as high as $150 to $200 apiece; but with the arrival of the break-up their selling value will drop to zero. The men get into their sleeping bags, which are quickly warmed by the heat of their bodies, and soon are fast asleep. On the icy surface of the lakes the night winds drive the snow, and the northern lights quiver and dance; but the travelers are tired, and sleep on until the pale twilight of early morn wakens them to another day of mushing.

From Hudson to Red Lake it is good going to make the distance in five days when the trail is in fair condition. Often seven days are none too long. One man drawing a lightly loaded toboggan has on occasions been known to do it in four days or even less, but such performances are few. On the way there are no roadhouses, no places of entertainment, not even an Indian encampment. The only habitations are at Pine Ridge, at the foot of Lac Seul, where the Hudson's Bay Company has a trading post consisting of the factor's dwelling and an old building known as the Indian House, from the fact that Indians gathered there in by-gone days when trading their furs for the company's goods. Most of the way is over frozen lakes. These lake routes have their advantages, also their disadvantages. They are level, and thus holes and rocks are avoided; but the snow drifts before the wind, and, perhaps worst of all, the water of the lake frequently rises above the ice and converts the bottom layers of snow into slush. This makes the going very hard.

Great things were expected of "snow-mo-

Photos. W. H. Alderson.

Dog teams and airplanes have proved effective means in reaching Red Lake in wintertime.

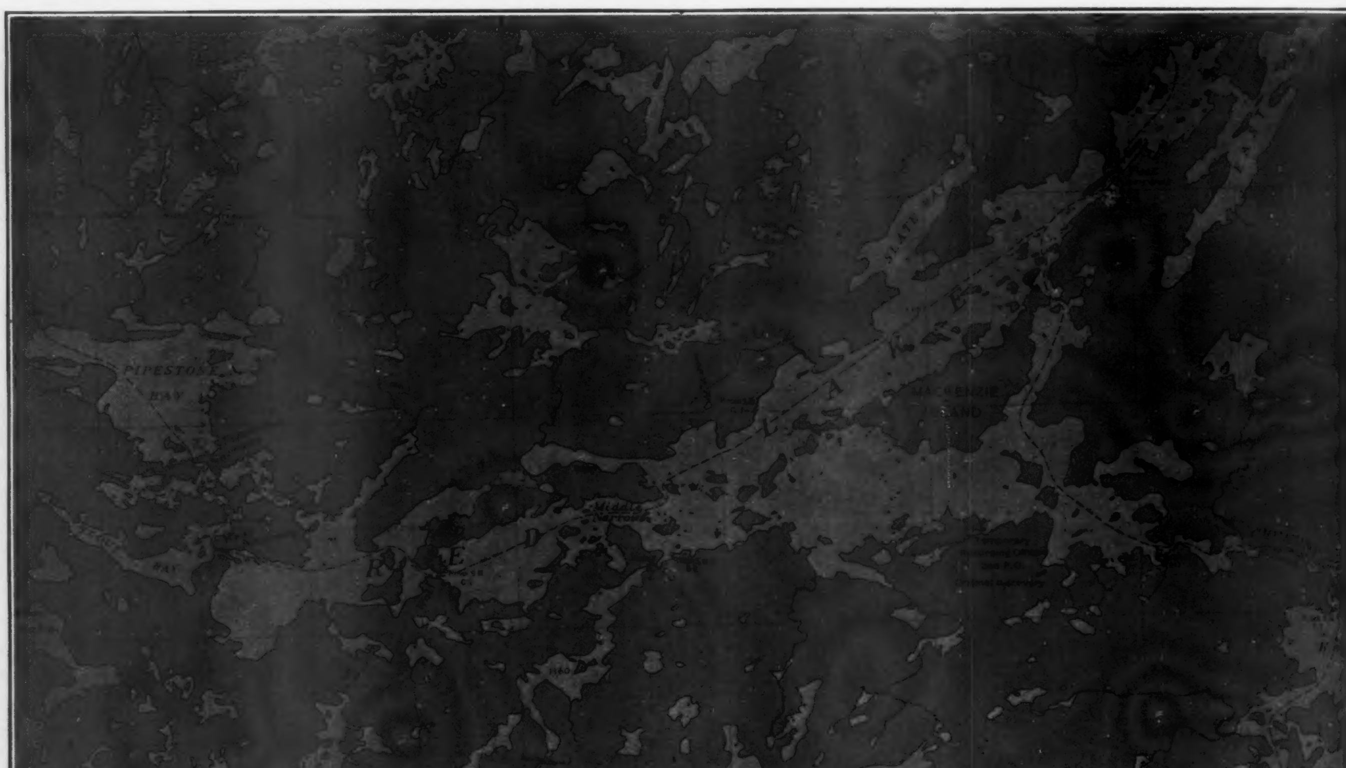
tors" in transporting men and supplies. These tractors consist of a body resembling that of an automobile mounted between parallel cylinders having spiral flanges, the rotation of which gives the machine its onward impulse. On dry snow the snow motors performed fairly well; but slush gathering and freezing on the cylinders put them out of business, so that they were soon abandoned. Horses had better success once a road bottom was established. Heavy rollers are used to harden the snow for roads. At the present time of writing large quantities of camp supplies and mining machinery, such as drills, are being taken in over the snow road—as many as 40 or 50 teams of horses being employed. The drills are for use on the Howey claims and also on the adjoining group under option to the McIntyre-Porcupine Company. Readers who know the mines of the Porcupine gold camps will recognize the McIntyre as another of the "big three." All food and commodities of every kind must be brought in from the railway; and, as may be supposed, prices are high. An airplane service has been inaugurated from Hudson; and, when weather permits, passengers are carried for $100 apiece. Rates for baggage are 50 cents per pound. The flight is made in an hour and 40 minutes.

Red Lake abounds in fish, mainly pickerel and trout. As yet no buildings have been erected there, the single exception being a small log structure used as a bath-house by the Finnish laborers. All workmen employed during the winter lived in tents. The region is one of unbroken forest, mainly of spruce and jackpine. Some of the spruce trees are 2 feet in diameter; and there is an immense quantity of timber suitable for pulpwood and not a little for saw logs. In the valley of the English River, some distance south of Red Lake, there is a large area of first-class agricultural land without a single settler. Grain, hay, potatoes, and other vegetables not only mature but do well there; and if Red Lake camp fulfills expectations, this arable land will undoubtedly become the home of an agricultural settlement supplying produce for the mining communities.

The method of taking up mining claims deserves a word. All land belongs to the Crown, or, in other words, to the Government of Ontario. A prospector must have a miner's license, which costs him $5. All licenses expire at midnight on March 31 next after their issue; and, as an ungranted mining claim requires a current license to maintain its validity, it is vital to the prospector to see that he gets a renewal by the 1st of April. A mining claim is a square, 20 chains to a side, containing 40 acres. The sides of the claim run north and south, and east and west, respectively. It is staked out by placing four posts—No. 1 Post at the northeast corner, No. 2 at the southeast corner, and so on. When in a timbered region, it is necessary to run blazed lines between these markers. Application must be made to the local recorder within 15 days after staking, with one day additional for each 10 miles distant from the recorder's office. A special law was passed by the legislature allowing an additional 20 days for recording claims in the Red Lake mining division. Thirty days' work must be done on a claim within three months after recording—there being a closed season between November 16 and April 15, following, and 40 days' work each succeeding year until 200 days' work in all have been done. On completion of the work and the filing of a survey by an Ontario land surveyor, the holder of the claim pays $2.50 per acre and receives a grant in fee simple. Failure to do the prescribed work in the time limit given in the Mining Act works a forfeiture, and the claim may then be "jumped" or staked out by another license holder.

The government opened a recording office in a 12x24-foot tent on the shore of Red Lake. The equipment was of the simplest. A sheet-iron stove furnished heat, and the improvised stovepipe emitted live brands which had a habit of falling on the tent and burning holes in it. Packing cases came in handy for office desks and for storing records. Here, T. A. McArthur and H. E. Holland recorded the applications filed by prospectors—numbering them in consecutive order and handing out "abstracts," that is, copies of the office records. On the strength of these abstracts a prospector can sell his claims for a good sum, particularly if they are "close in" to the established gold discovery. As substantially all the claims recorded so far—3,000 or more—are snow-shoe stakings, the purchaser takes a big chance. But he knows this, hoping his ground will reveal gold when the snow goes. Provincial Police Constable L. C. Carr represents the forces of law and order; but Ontario mining camps are proverbially quiet. Mutt-and-Jeff-at-Red-Lake stuff, such as is shown in Bud Fisher's comic strips, is a laughable travesty on the real conditions.

Prospectors are a picturesque class, meaning by prospectors men who have followed the calling all their lives. "Once a prospector



Red Lake area around which the latest gold rush centers.

Left—New arrivals at Hudson.
Right—Red Lake teems with toothsome fish.

always a prospector." The free, untrammeled life in the woods has a strong appeal to many men of the North. They live in an atmosphere of optimism and hope. They may take a job, say in a mine, for the winter months; but when the spring breezes begin to blow, and the ice moves out from the lakes and rivers, the prospector becomes uneasy. He and his partner get out and repair their canoes, overhaul their equipment, find someone to grubstake them, and are off to the woods again. They are an intelligent lot. Though not usually highly educated, they frequently become adept in reading and interpreting the significance of the rocks and the geological reports or maps. Technical terms used in geology, unintelligible to most men in ordinary walks of life, are full of meaning to them. They know that conglomerate rock at Cobalt is the favored rock for veins of silver. The contact of granite and Keewatin or the upthrust of a porphyry dike is to them an open book, and there they look for gold. In the great nickel fields of Sudbury, diorite—later called diabase, norite, or gabbro—was the watchword among prospectors; in Cobalt it was conglomerate; in Porcupine, porphyry; and at Red Lake the rock associations are similar to those at Porcupine.

Not many prospectors become rich. They cannot carry a mining prospect very far without the assistance of capital. Capital is inclined to make its own terms, and the prospector haggles at a disadvantage. However, if his find be a rich one, he may hold out not only for a certain amount of cash but for a substantial interest which, if the mine prove successful, may yield him a fortune. The mining fields of Ontario have brought some prospectors wealth. Bill McVittie, a survivor of the Sudbury nickel field, is an example. W. G. Trethewey, lately deceased, Alex Longwell, Hugh Kerr, George Glendinning, and Arthur Ferland came well out of the Cobalt silver camp. Not much of the great wealth of Porcupine remained with the actual prospectors. Poor Benny Hollinger was perhaps one of the exceptions. At Kirkland Lake, Harry Oakes and M. Wright made their pile. The oldtimers now busy swapping Red Lake claims include Tim Crowley, aged 74, whose boast is that he took the first team of horses into Red Lake last winter; the McDonough boys and the Howeys, who have given their name to the group of claims now occupying the center of the stage; Faulkenham, Cockeram, Cochenour, Willans, Aleck Gillies, and Mike Bouzan, who fought in the great war alongside several of his sons, and many others. Most of the big mining companies have acquired groups of claims. Besides those already mentioned, there are Nipissing Mines, Coniagas Mines, Noranda Mines, and Victoria Syndicate; and now a growth of new concerns formed for the occasion is springing into life.

Perhaps no other mining field has ever received so much advertising in the press as Red Lake since the discoveries were made. The flying machine—making the journey from the railway into Red Lake in two hours or less, as against a week's steady mushing through the snow—has added a picturesque touch to the story. Red Lake has been broadcasted on the radio; it has been filmed for moving pictures; and the newspapers of New York and other cities in the United States have featured it in story and illustrations. Altogether, it has been and still is a most interesting episode, with not a little of the thrill in it. Additional discoveries have been made notwithstanding the mantle of snow which has covered the ground since October; and new fields—such as Birch Lake and Woman Lake on the east, and Rickaby and Bee lakes on the Ontario-Manitoba boundary on the west—have all been found to contain gold.

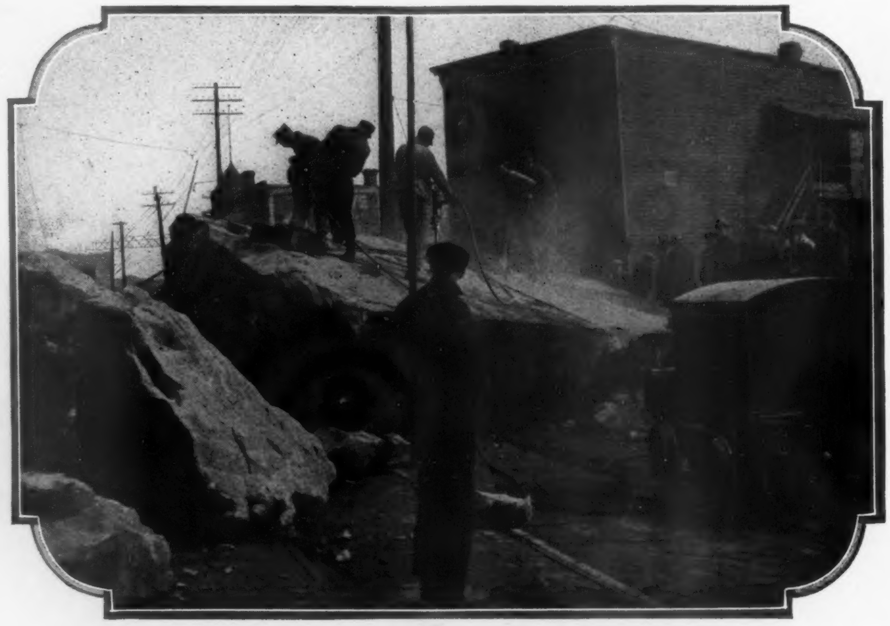
A great future is by many prophesied for the mining industry of Patricia—this future hinging on the results which the diamond drills will reveal at depths on the Howey and McIntyre claims. Should expectations be realized, due honor should be given to such men as the ill-fated Gilbert and to D. B. Dowling and Charles Camsell—who first explored and described the geology of the Red Lake and adjacent areas, and also to E. L. Bruce, whose careful, scientific eye noted signs of the hidden possibilities in the rocks, and who in sober language described what he saw, neither boosting nor knocking.

In at the start at Red Lake. From left to right: H. E. Holland, Mining Recorder; G. F. Summers, Ontario Land Surveyor; T. A. McArthur, Inspector of Mining Recorder's Office; and J. E. Hammell, mining engineer.

Blocked Highway Quickly Cleared

By THE STAFF

A SHORT time ago, many of the residents of Duluth, Minn., were suddenly startled when a huge boulder, estimated to weigh at least 1,000 tons, fell 70 feet from the top of the Point of Rocks on to Superior Street, one of the city's main thoroughfares. The rolling down of the rock was likened to an avalanche; and the noise made by the descent was heard, so it is said, as far as the outermost sections of the community.

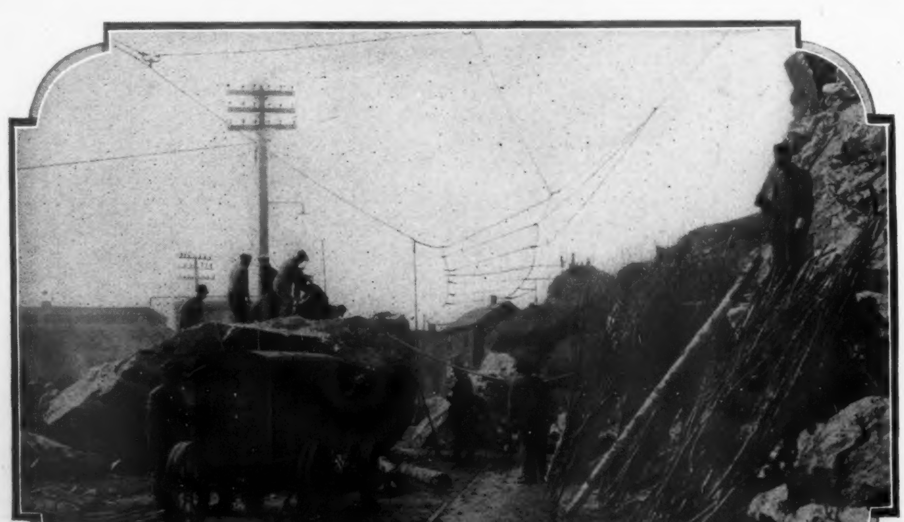


This 1,000-ton mass was detached from Point of Rocks, in Duluth, Minn., by a blast intended to increase the safety and not to block the neighboring busy thoroughfare. The fact that the concussion released the great piece of rock disclosed how insecurely it was attached to the towering nearby ledge.

The huge boulder, which in all probability had rested on the peak of the Point of Rocks for untold centuries, had for many years been considered a menace to pedestrians and to traffic; and its dislodgment by drilling and blasting was therefore undertaken, with the results as just described. As the greater portion of the rock rested on the car tracks, both the city officials and the authorities of the trolley company took immediate steps to clear the street as soon as possible. So efficiently was the task handled that only six hours elapsed from the time of the accident—ten o'clock in the morning—until the resumption of trolley service and the use of the street by vehicular traffic.

Luckily, the wherewithal to quickly break up the boulder was near at hand. A few blocks below the scene of the accident there was a building under construction; and, to facilitate certain work that he had to do, the contractor was provided with a Type Fourteen portable compressor. This machine was at once pressed into service, together with the portable that was already on the spot and that had furnished air to the pneumatic drills employed in the first place in removing the rock that was causing the trouble. To hasten matters, a tie-tamper compressor unit, the property of the trolley company, was rushed to the site to supply additional air for the operation of the several DCR and BCR "Jackhamers" available.

In one hour from the time that the rock had been loosened from its perilous position and had rolled on to Superior Street, tying up traffic, the three compressors and the five rock drills were all working at top speed. As soon as two or three holes had been drilled, they were loaded with small charges of dynamite and fired. Immediately after each blast, the men armed with the "Jack-hamers" jumped to t newly severed piece o the rock and again starte drilling. This alterna drilling and blasting di not cease until a stea shovel, also drafted fo the work, could eithe push the rock to one sid or load it on to a truc to be carried away. Fo o'clock in the afternoo saw the trolley cars agai passing along Superio Street.



Five "Jackhamers," drawing operating air from portable compressors, made it possible to drill and blast the obstructing rock so that the highway could be cleared in the course of the brief span of six hours.

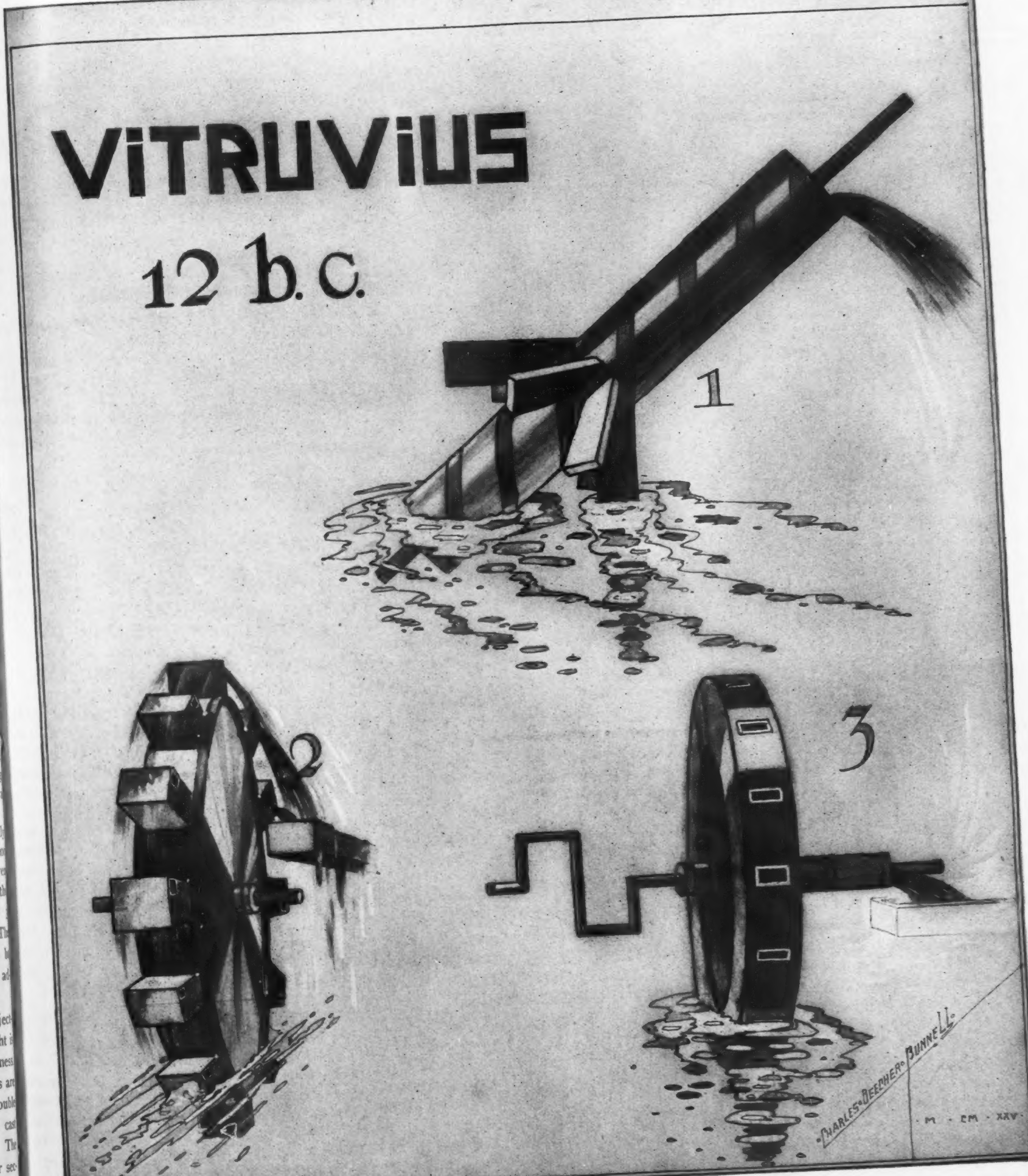
According to the lates statistics available, thos for 1924, the averag value of school proper in the United State amounted to $154 pe pupil enrolled.

NEW AUTOMOBILE HEADLIGHT

A RADICAL change in automobile head light construction can be expected in th near future, according to W. D'Arcy Ryan Director of the General Electric Illuminatin Engineering Laboratory, and inventor of a headlight with several novel features.

It is claimed that this new light not only illuminates the roadway for a distance of 2 feet but also makes road signs readable eve when the front of th car has gone 2 or feet past the sign. Th light is also said to b non-glaring—another ad vantage.

Including the project ing lens, the headlight i but 3 inches in thickness The reflector and lens ar so made that a doubl crescent of light is cas from each lamp. Th light from the upper sec tion is the long-range beam, and the light from the lower part, inverted by means of the reflec tor, is superimposed o the other light in such a way that the illuminatio is spread evenly over th road and shines on th ditches on either side.



ROTARY PUMPS DEVISED BY ENGINEER OF ANCIENT ROME

MARCUS Vitruvius Pollio—generally known as Vitruvius, is reputed to have been in the service of Julius Ceasar and Augustus in the capacity of an architect and a military engineer. Vitruvius lived about 12 B. C.

Vitruvius is supposed to have had a prime part in working out the water-supply system of ancient Rome; and among his suggestions for handling water were some that had to do with irrigation by means of rotary pumps. Three types of rotary pumps, ascribed to Vitruvius, are here illustrated.

Fig. 1 shows a spiral pump with a bevel undershot wheel attached—the pump being rotated by stream currents. Fig. 2 is another form of undershot wheel in which the buckets act as paddles to impart the required rotary motion. The buckets filled themselves and retained the water until they arrived at the proper point in their travel, when they emptied themselves into the designed channel. Fig. 3 shows a small hand wheel having ports on the rim that open into a series of spirals converging toward the central hub. The water thus reached a hollow shaft from which it was discharged. The pump could be operated easily by one person or speeded up by the joint labors of two.

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EDITORIALS

DELAWARE RIVER BRIDGE OPENED TO TRAFFIC

WITH the opening to traffic of the Delaware River Bridge on the Fourth of July will be brought to its climax an engineering undertaking of the first magnitude. This great suspension bridge, with a span of 1,750 feet between the towers on opposite shores of the river, is just one more evidence of the influence of motor transportation. In the days of the horse-drawn vehicle, the river ferries were adequate; but with the coming of the automobile, and later the widened use of the motor truck, the ferries could not take care properly of the peak-load periods of automotive traffic.

It was, therefore, inevitable that some other means of crossing the river should be provided; and it is to the credit of the two states immediately concerned—Pennsylvania and New Jersey—that they took the steps essential to furnishing a solution. The Delaware River Bridge is a magnificent example of what the modern bridge designer and his engineering associates can do when called upon to do their best. The structure has required the mastering of many technical problems and the surmounting of numerous obstacles in giving the towers firm foundations and in providing proper anchorages for the cables which hold aloft the deck of the bridge. Particulars regarding the structure have appeared in our pages from time to time—inspired primarily by the important parts played by compressed air in making progress possible. The work has gone forward with notable smoothness; and everyone identified with the task is deserving of heartiest commendation.

The Delaware River Bridge will, undoubtedly, prove a boon not only to Philadelphia and Camden but to outlying and tributary territory on each side of the river. To the touring motorist, bound east and west, or north and south, this highway across the Delaware will be the means of saving much time and many inconveniences.

OUR SESQUICENTENNIAL

ON the Fourth of July we shall celebrate throughout the length and breadth of the land the one hundred and fiftieth anniversary of our coming into being as an independent nation. To cover the story of our progress as a people since we started out to stand on our own feet and to be the masters of our own future would take many volumes. Perhaps the critic could justly point to mistakes that we have made from time to time as we forged forward on the course of our choice; but, taking our record as a whole and considering the estate to which we have grown, the good things accomplished far outweigh all our errors.

Looking back over the century and a half gone, the changes wrought within our land in the interval are nothing less than astonishing. As a nation we have evolved, so to speak, from a village to a metropolitan life—effecting the while a stupendous revolution in everything connected with our industrial, economic, and social life. Never before in the history of the world has so much been achieved by any other nation in the way of material progress. It would be well if everyone of us pondered this fact that warrants pride and yet furnishes ample reason for sober thought and speculation.

If we are to go steadily onward at the quickened pace which has become our habit, then our individual responsibilities will increase proportionately. It is becoming more and more necessary that everyone of us should concern ourselves in all matters relating to public welfare and see to it that we voice our opinions at the polls whenever we are asked to vote upon local, state, or national questions. It was this vigor of expression that made us strong in the beginning; and the same participating energy is even more needful now in these days of increased complexities.

NATION URGED TO SAVE "OLD IRONSIDES"

TIME and again many millions of us have thrilled to the recital of the doughty deeds of "Old Ironsides" and of the part she played in those anxious days when our fighting ships were pitted against the craft of the greatest of sea powers! The United States Frigate "Constitution," as the vessel was and still is officially registered in the Navy List, enjoyed a charmed career in the hands of her several able commanders—she was able not only to outfoot but to outfight all her opponents. In one memorable combat she whipped at the same time two of the enemy's sturdy craft not so much because of the superiority of her battery as because of the exceedingly skillful manner in which she was maneuvered so as to take her foe's separately at a disadvantage.

It has been many years since the U. S. S. "Constitution" saw active service, and then she sailed to European waters to carry food and substantial relief to famishing Ireland. Since the time of her launching in 1797, as is always the case with wooden vessels, the ship has been substantially repaired on a number of occasions; and it is doubtful if a single piece of her original structure now remains in her get-up. Even so, she has been preserved in form virtually as her hull was first fashioned, and about her still lingers the inspiration of tradition. In other words, she is a monument that should appeal to every patriotic American, but a monument that is in a fair way to be lost unless steps are soon taken to rehabilitate her decaying timbers.

The school children of America have recently contributed $192,000 towards putting the ship into proper condition, but a total of half a million dollars is necessary to do this work in the way it should be done to keep "Old Ironsides" afloat. Surely, there are enough of us in this country, conscious of what the U. S. S. "Constitution" did for us in the past, to want to see her preserved as a patriotic shrine and as an inspiration to battle on even though the odds may seem to weigh heavily against us. A trifling contribution from each of us would be ample to meet the situation and to insure the saving of "Old Ironsides."

FORESTALLING EXTENSIVE UNEMPLOYMENT

IT will be recalled that the late PRESIDENT HARDING called a conference on unemployment in 1921. Since then, this industrial problem has been the subject of much study; and a report has now been made on this problem by a committee of the American Statistical Association.

An advance notice of this report, issued by the Russell Sage Foundation, says the plan endorsed has for its object "to lessen unemployment by providing facts needed to understand and to control fluctuations in the production of goods and obstructions to their sale"—these interruptions in economic processes leading to the throwing out of work the men and women concerned.

The plan presented calls for the collection of employment statistics by state labor bureaus, with the United States Department of Labor the coördinating center. In addition, the plan commends and urges the extension of the regular collection of employment statistics by federal bureaus having a direct relation to certain industries—such as the Geological Survey for mines and quarries, the Interstate Commerce Commission for railroads, and the Department of Agriculture for farms, and the reporting of all these data to the Federal Bureau of Labor Statistics for prompt publication of national indices of employment.

Answers to two main questions are sought in the proposed monthly surveys: The total number of employees on each payroll, and the total amount of wages paid in the monthly payroll period. If the plan advocated is carried out, so the committee says, "Information will be available for business men, bankers, and social agencies, which will show each month for every important industry, for every state, and for

every important community and industrial area, whether the number on the payrolls and the total wages paid are less or greater than in the preceding month, in the preceding year, and at other periods significant for comparison."

In the end, this fund of information will provide essential facts upon which banks and business men may control their investments or their endeavors so as to stabilize efforts and undertakings in a manner to avoid the dangerous peaks and hollows of our economic extremes.

ARTIFICIAL LIGHT TO DO SUN'S WORK

THE therapeutic value of sunlight is well known in combating a number of diseases. This is due in part to the corrective or actinic action of the violet rays. The United States Bureau of Standards has devoted considerable attention to developing a type or types of arc lamps that will produce light that closely approximates sunlight in this particular. Very encouraging results have rewarded these efforts.

According to a recent dispatch from Washington to *The Sun* of New York City: "A lamp giving such rays would be invaluable in the treatment, if not the cure, of a wide variety of germ diseases or in the treatment of infected wounds—all of which are benefited by sunlight. A number of arcs are now in use experimentally, and several are being studied which will produce 16 per cent. of violet rays compared with 18 per cent. for the sun at noon. The work is under the direction of DR. W. W. COBLENTZ, physicist at the bureau."

This revelation is only one more evidence of the extremely varied nature of the valuable work done by the United States Bureau of Standards. Many millions of people will be interested in the news and wish the bureau the utmost of success in this field of physics.

At a recent meeting in Philadelphia of the Philadelphia Section of the American Society of Mechanical Engineers, Mr. H. S. Harris was elected president of the local section of that organization. Mr. Harris is connected with the Philadelphia office of the Ingersoll-Rand Company.

It has been announced that the Second International Foundrymen's Congress, under the auspices of the American Foundrymen's Association, is to be held this year at Detroit, Mich., during the week of September 27. One of the novel features of the Congress will be a round-table discussion of practical shop problems planned for the benefit of shopmen, as well as metallurgists and executives.

Vancouver, Canada's leading port on the Pacific, has been developing rapidly within recent years. The extent of the growth can be appreciated when it is known that 40 ocean steamship lines now operate out of Vancouver, as against 21 in 1920.

TIN AND THE TIN INDUSTRY, by A. H. Mundey. An illustrated book of 130 pages, published by Isaac Pitman & Sons, New York City. Price, $1.00.

THIS volume is one of a comprehensive group of works having to do with common commodities and industries, and like all the others of the series, the subject is handled in a clear and sufficiently comprehensive manner by the author. The book has been inspired by an apparent lack in the general bibliography of metals. As Mr. Mundey explains, "Although in the large treatises the purely scientific aspects of the metallurgy of tin, its chemical and physical character, and its uses in engineering, manufacture, and the arts are discussed in great detail, it is difficult to obtain, in an inexpensive and handy volume, a concise account of the chief facts of importance concerning a metal which must of necessity have some interest for everyone. It is to meet this need that this little volume was presented."

RESEARCH NARRATIVES, Vol. II. A book of 174 pages, published by the Engineering Foundation, New York City. Price, $1.00.

THIS admirable little volume contains 50 brief stories of research, invention, and discovery, told in the language of the layman, and coming directly from the "men who did it." The volume contains a wealth of interesting topics; and the following of them are cited not because they are the most absorbing but because they serve to give a fair idea of the varied nature of the different contributions. Among the half hundred are these narratives: *Marine sounding by sound; The haunted restaurant; Supremacy of artificial life; Concrete-boring mollusks; Old Nick's own metal; Making corncobs useful; Bringing high altitudes down to earth; Modernizing the steam locomotive;* and *How food got into tin cans and glass jars.*

THE LIFE OF PASTEUR, by R. Vallery-Radot. A work of 484 pages, published by Doubleday, Page & Company, New York City, and distributed by The Chemical Foundation, Inc. Original price, $3.00.

THIS work is a centennial recognition of the birth of Louis Pasteur, to whom we owe so much for some of the most effective means now at our disposal in combating various forms of disease. Like all men of outstanding originality of thought—a pioneer in his chosen field of science—Pasteur had to fight long and bitterly against the accepted views of the medical profession towards many of the theories advanced by him.

It is recalled that Pasteur was early impressed with the analogies between fermentation and putrefaction and the infectuous diseases, and in the early "sixties" he announced that his ambition was "to arrive at the knowledge of the causes of putrid and contagious diseases." After a study upon the diseases of wines, which has had most important practical bearings, Pasteur next turned his attention to a disease of the silkworm, which had threatened to ruin one of the greatest of the industries of France. After years of effort, Pasteur won a brilliant success in this line of investigation. It is not possible for us to say more about the genius of this great man other than to repeat that his researches upon fermentation and spontaneous generation brought about a veritable transformation in the practice of surgery.

THE RIDDLE OF THE RHINE, by Victor Lefebure. An illustrated book of 282 pages, published by The Chemical Foundation, Inc., New York City.

NO matter what may be our personal views regarding chemical warfare, still this method of attack as well as of defense established its effectiveness at various times during the recent great conflict. The author in his opening chapter says: "The great war challenged our very existence. But with the tension released, and the Allies victorious, the check to the German menace appears crushing and complete. Few realize that one formidable challenge has not been answered. Silently menacing, the chemical threat remains unrecognized. How, asks the reader, can this be? Are we not aware of the poison gas campaign? Indeed, we have not yet grasped the simple technical facts of the case, and these are merely the outward signs of a deep-rooted menace whose nature, activities, and potentialities are doubly important because so utterly unsuspecting by those whom they most threaten."

The author has been inspired to write because of the silence surrounding the true facts of the chemical campaign; and the object is to point a moral, to sound a warning that those most concerned may give due heed.

Pneumatic tool pocket list for railway shops. This is a complimentary handbook issued by the Ingersoll-Rand Company, 11 Broadway, New York City. It is copiously illustrated and shows graphically the principal uses of pneumatic tools in railway shops. Incidentally, it contains much essential information that should be of value to men engaged in this particular field of industry. The book is of 124 pages, but is so convenient in size that it will readily slip into a pocket.

Relations between the temperatures, pressures, and densities of gases is the title of Circular No. 279 recently issued by the United States Bureau of Standards. Price, 25 cents.

Research associates at the United States Bureau of Standards is the title of Circular No. 296. Price, 10c. Sold by the Superintendent of Documents, Washington, D. C.

Progress report of Metallurgical Advisory Board to Carnegie Institute of Technology and United States Bureau of Mines. This is the

title of Bulletin No. 27 issued by the Carnegie Institute of Technology, Pittsburgh, Pa.

The United States Bureau of Mines has given out the following list of new publications:

BULLETIN 197. *Sampling and examination of mine gases and natural gas,* by George A. Burrell and Frank M. Seibert. Revised by G. W. Jones, 1926. 108 pp., 8 pls., 27 figs. Price, 25 cents.

BULLETIN 242. *Explosion hazards from the use of pulverized coal at industrial plants,* by L. D. Tracy. 1926. 103 pp., 36 figs. Price, 25 cents.

BULLETIN 253. *Possibilities for the commercial utilization of peat,* by W. W. Odell and O. P. Hood. 1926. 160 pp., 6 pls., 23 figs. Price, 35 cents.

TECHNICAL PAPER 363. Lessons from the fire in the Argonaut mine, by B. O. Pickard. 1926. 39 pp., 4 pls., 6 figs. Price, 15 cents.

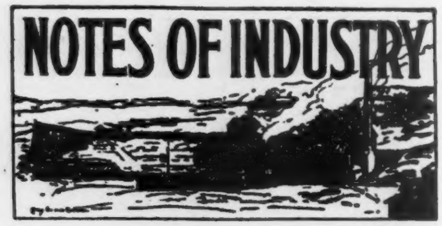
Copies may be procured from Superintendent of Documents, Government Printing Office, Washington, D. C.

BOLIVIA BECOMING A BIG LEAD PRODUCER

BOLIVIA promises to become one of the world's leading lead-producing areas. Until two years ago, according to *Commerce Reports,* substantially all the lead produced in Bolivia was mined in the Department of Tarija, near the Argentine frontier. But during 1924 and 1925, native miners and operators have turned their attention to the exploiting of lead deposits, which are to be found in well-nigh every part of the great area lying between the western and the eastern Cordilleras and extending from Lake Titicaca southward to the Argentine border. The latest deposits discovered, on the shores of Lake Titicaca, are now being worked on a rather large scale, and have been producing ore averaging 75 per cent. lead and containing 80 ounces of silver per ton. Together with other lead mines, opened nearby, this region is now yielding 200 tons of lead a month. But the development of the industry can be better appreciated when it is known that the output has been increased from 8,986 tons in 1923 to 36,837 tons in 1925. The prospects are that this year's output will reach the 45,000-ton mark.

AUSTRALIA PLANS BIG IRRIGATION SYSTEM

THE Dawson Valley irrigation scheme, now under consideration in Australia, involves the impounding of the waters of the Dawson River and their distribution by gravity, or otherwise, over the lands of the Dawson River Valley. At the Nathan Gorge, on the Dawson River, a dam is to be constructed 200 feet high and 820 feet long, with walls 80 feet thick at the base and 16 feet thick at the top. This dam will impound 2,500,000 acre-feet of water. The irrigation canal will follow the river for about 40 miles until it reaches Delusion Creek, where an off-take weir is to be constructed to regulate the flow through the irrigated areas. The cost of the project, if carried out in its entirety, will exceed millions of pounds.



Japan is planning an extensive roadbuilding program that is to involve an initial expenditure, over ten years, of $6,000,000. A great highway is to be built from Keelung, in the extreme north of the Island of Formosa, to Takso, in the south, and thence east to Heito. Besides the construction of 287 miles of roadway, there will be built 21 large and 510 small bridges, and 1,140 viaducts and culverts. Except in the mountainous regions, where a 36-foot minimum is permissible, the highway is to have a width of 48 feet. Additional appropriations and another 10-year period will be required to fully complete the undertaking.

A practical substitute for glass, described by a correspondent of *Ceramic Industry,* is finding favor for special uses in England, where it is being manufactured by the Windolite Company, of London. The material, known as Windolite, is composed of a cellulose acetate reinforced by wire netting, and is said to have great tensile strength and to be well-nigh unbreakable. It is manufactured in two different strengths, and is sold by the yard. It can be readily cut and shaped with suitable scissors, is washable, does not easily discolor, and admits considerable light—especially ultra-violet rays so contributive to health.

A portable cement gun, weighing about 200 pounds, has recently been put on the market by the Cement Gun Company, Inc., of Allentown, Pa. Low consumption of air and portability are the two distinctive features claimed for the outfit by the manufacturer. Contractors, it is said, will find the equipment especially useful in doing patchwork or in mending concrete which has become honeycombed. As 60 cubic feet of free air per minute is sufficient to operate the gun satisfactorily, a 1-drill compressor is adequate to furnish the needful power.

Approximately 48 per cent., or 73,500 square miles, of Japan's total area is timberland largely because of its unfitness for agricultural and pastoral purposes.

The shore end of a new cable, linking Newfoundland and England, was landed recently at Sennen Cove, Cornwall. The cable, designed by the Western Electric Company, will transmit 2,500 letters a minute—four times the capacity of the older lines.

At the present time, the world's annual newsprint production is about 5,500,000 tons. Approximately 55 per cent. of the 1925 output came from the United States and Canada, the two countries contributing well-nigh equally.

Street-car lines of Zürich and Basel, Switzerland, as well as those of several other European cities, have been experimenting with a new type of brake having a braking surface of carborundum. Instead of applying pressure on the wheels of a car, this device applies pressure on the rails by means of two sets of shoes, one on each side of the single-truck frame. These shoes are pressed down on the track with compressed air. Needless to say, no sand is required to assist in stopping a car quickly. The brake, however, is recommended for emergency use only, because frequent contact with the carborundum would cause considerable wear and tear on the head of the rail.

Exports of industrial machinery from the United States in 1925 had a total value of substantially $150,000,000, representing an increase of 14 per cent. as compared with 1924.

In November of 1925, the Hungarian Parliament passed an act creating a new monetary unit of gold to be known as the *pengo.* The name of the new currency, which is to be put in circulation in November of this year, was selected to prevent its translation into foreign languages and, at the same time, to increase confidence in it locally. Literally, *pengo* means jingler—in other words, it denotes the return in Hungary of currency of ringing metal. One *pengo* is equal to about $0.175 in United States currency.

Plans are being made for the restoration of the old irrigation system of Iraq—consisting of river-fed canals—which was the source in the days gone of the prosperity of the Tigris and the Euphrates Valleys. It has been estimated that it would be possible in this way to reclaim again as much land in this part of the world as irrigation has made productive in the Nile Valley.

During the present summer, a $2,000,000 cold-storage plant is to be constructed at Halifax, which has been experiencing a tremendous growth in its shipping business. More than 11,000,000 tons of commodities were handled at that port in 1925, an increase of 3,000,000 tons as compared with 1924. Because of this activity, it has become necessary to provide additional cold-storage facilities for Nova Scotia fruit, and dairy and other farm products, as well as for a large amount of produce from the Dominion intended for overseas shipment. When completed, a force of 600 men will be required to run the plant.

Sweden has recently completed the electrification of 300 miles of trunk lines.

According to estimates made by Professor Stella, there is a reserve in the Italian iron mines of approximately 108,000,000 tons of ore. Of this total, 45,000,000 tons is easily accessible.

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